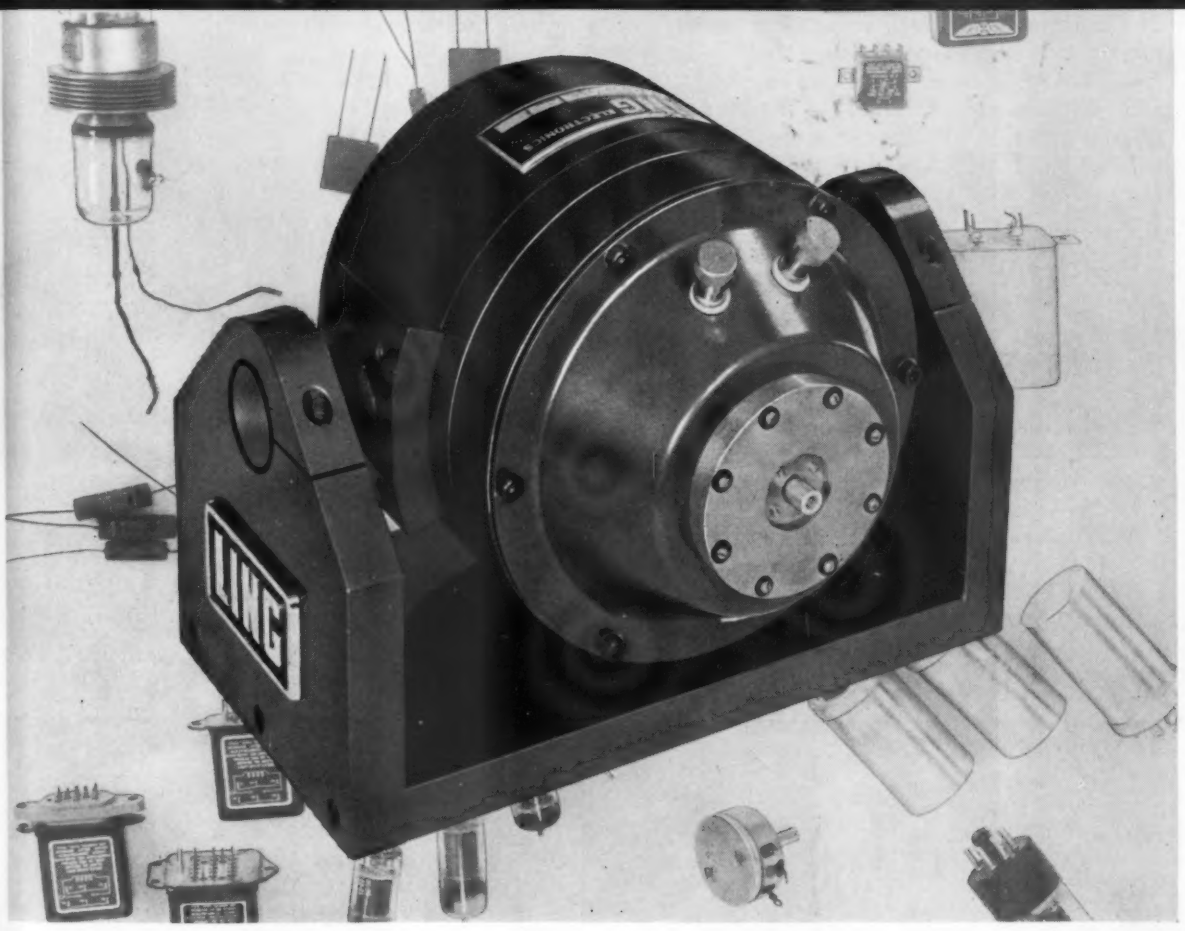
ENVIRONMENTAL QUARTERLY

October • 1960

The Pioneer Space Age Publication of Environmental Simulation, Testing, Engineering and Equipment Manufacturing

INDEPENDENTLY PUBLISHED

Volume 6 • Number 4



LING'S NEW PERMANENT MAGNET BABY SHAKER

First of its kind in the country, the new Ling Permag LPM-25 Shaker meets industry's urgent demand for a small shaker for light component testing and back-to-back calibration. With the LPM-25, the manufacturer of electronic tubes and small components can economically give his products a full vibration test, or use as a production quality control. Strict linearity throughout the wide 5-20,000 bandwith (first resonance above 10 kc with one accelerometer) is provided by a unique suspension system. Special features include: Back-to-back calibration up to 100g without special mounting devices, aged permanent magnet, low driving power, excellent linearity, total distortion for 10g 1% over most of the frequency range, shaker trunnion isolation which reduces vibration transfer to supporting structure. Available as a complete laboratory system, ready to plug in and operate. For details on this revolutionary development in vibration testing, write Department EQ-4 at our Anaheim address.

LING ELECTRONICS

A DIVISION OF LING-TEMCO ELECTRONICS, INC. • 1515 SOUTH MANCHESTER, ANAHEIM, CALIFORNIA • 120 CROSS STREET, WINCHESTER, MASSACHUSETTS

dynamic instrumentation Σ

NEW ACCELEROMETERS—After comprehensive design-proof testing Endevco introduced the 2220 series accelerometers in 1959. The unique physical design of this series is now further enhanced by Piezite® Element Type VI, a product of Endevco electroceramic research. This new crystal makes possible the unequaled combination of complete case isolation, high natural frequency (to 70 KC) and sensitivity (to 15 mv/g) in a versatile configuration of small size and light weight. Now Endevco announces, at no increase in price:

UNIQUE NEW "C" MODEL - GENERAL PURPOSE - 350°F ACCELEROMETERS

HIGH NATURAL FREQUENCY — LARGE SENSITIVITY — The 2220 Series retain these essential characteristics of all Endevco Accelerometers. The natural frequency of the mounted accelerometer is determined by actual frequency response and phase shift plots. Large sensitivity insures high signal to noise ratios over a wide dynamic range.

CASE ISOLATION — Complete case isolation prevents errors due to structural bending and high acoustic noise fields.

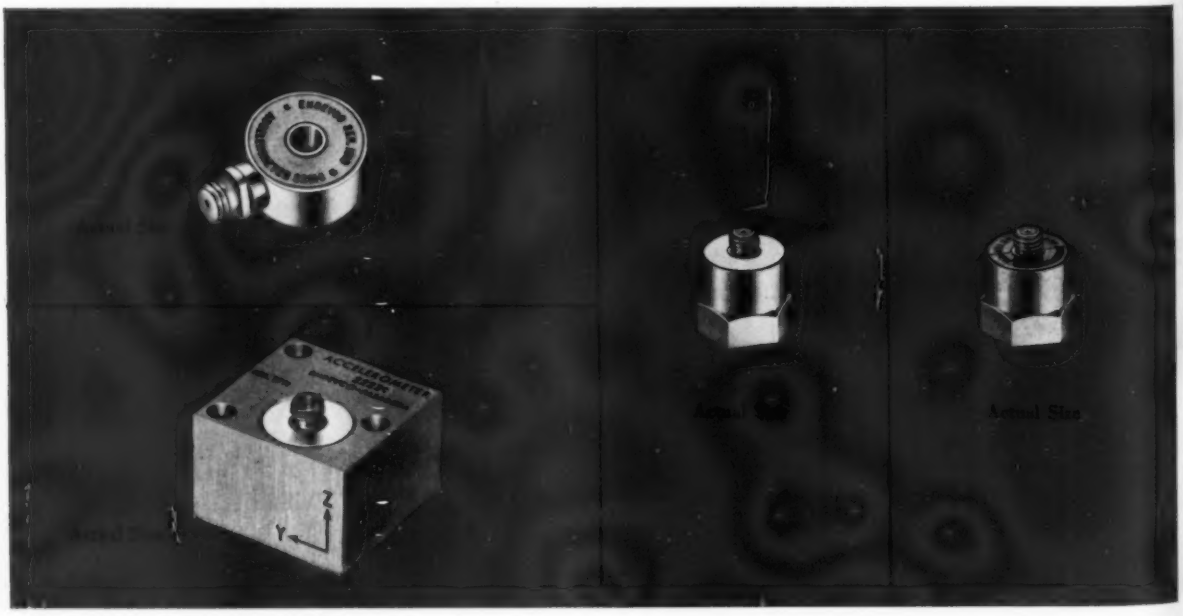
LOW CROSS AXIS SENSITIVITY — The annular design reduces cross axis sensitivity. Nominally 2-3% in the maximum axis and 0% in the minimum axis. A maximum of 1% in any axis can be supplied on special order.

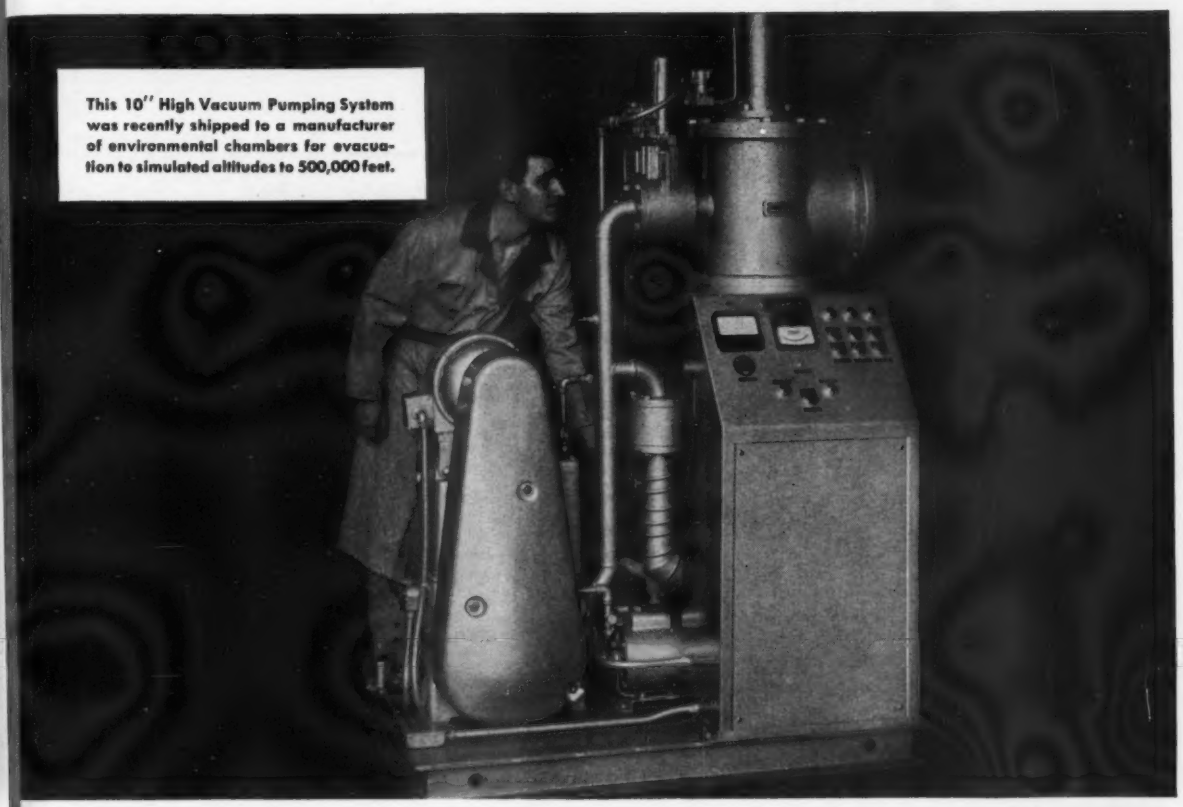
OPERATING TEMPERATURE OF +350°F —PIEZITE® Element Type VI makes possible a general purpose accelerometer with sensitivity vs. temperature linearity of ±10% from −65°F to +350°F without external swamping capacity. A maximum of ± 5% variation of sensitivity vs. temperature can easily be obtained with the addition of external capacity.

NBS TRACEABILITY — Every Endevco Accelerometer is provided with complete calibration data: Frequency response from 20 cps to 4 kc, cross axis sensitivity, capacity, voltage and charge sensitivity. Basic calibrations are traceable to the National Bureau of Standards as required by Mil. Quality Control procedures. Special calibrations of frequency, temperature and transient characteristics are available on request.

1. **MODEL 2221C** — The unique ring configuration permits ease of mounting in corners with long cables attached in limited space. Integral electrical ground isolation makes the Model 2221C ideal for either bolt or cement installation. Nominal sensitivity 15 pk-mv/pk-g—Capacity 750 μμfd—Weight 9 grams.
2. **MODEL 2223C**—Accurate triaxial vibration measurements can be made with minimum space (1" x 1" x 5/8") and weight (1.4 ounces). Integral electrical ground isolation is provided. Nominal sensitivity 10 pk-mv/pk-g — Capacity 750 μμfd — Meets Mil-E-5272B.
3. **MODEL 2224C** — Small size — top connector — 10-32 or ¼-28 insulated mounting stud available for ground isolation. Nominal sensitivity 10 pk-mv/pk-g — Capacity 750 μμfd — Meets Mil-E-5272B.
4. **MODEL 2225C** — **NEW** Shock Accelerometer. Natural Frequency above 70 kc — Nominal sensitivity 1.0 pk-mv/pk-g — Capacity 750 μμfd — Size 9/16 hex. by 0.52" high.

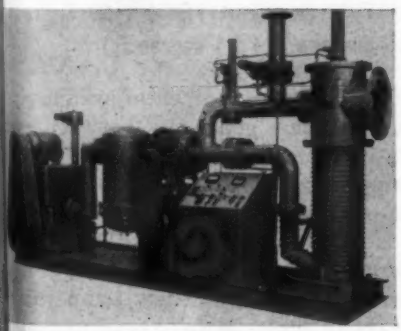
WRITE DIRECT TO DEPARTMENT S FOR LITERATURE **ENDEVCO CORPORATION** 161 EAST CALIFORNIA BOULEVARD PASADENA, CALIFORNIA. TWX: 7764 CABLE: ENDEVCO SYCAMORE 5-0271





This 10" High Vacuum Pumping System was recently shipped to a manufacturer of environmental chambers for evacuation to simulated altitudes to 500,000 feet.

SAVE DESIGN MANPOWER AND CUT COSTS WITH STOKES HIGH VACUUM PUMPING SYSTEMS



signed to evacuate an aerodynamic wind tunnel facility, is specially designed unit features 3 stages: me-anical pump, Roots type blower and 16" diffusion mp. System is base plate mounted and includes a phic control panel. The unit is one example of kes ability to meet out-of-the-ordinary system quirements.

Now, your valuable engineering time can be saved for direction to other phases of your project. Stokes solves the vacuum portion of your problem with completely packaged pumping systems. Whether your test needs are 150,000 feet or 1,500,000 feet of simulated altitude, and test volume requirements are 10 cu. ft. or 10,000 cu. ft., Stokes has the system to do an effective and efficient pumping job.

Stokes oil booster type and diffusion type systems are designed to meet your needs for *compactness*, *reliability* and *efficiency*. The 10" diffusion system in the illustration above, for example, requires only 20 square feet of floor space. Engineered around Stokes proven vacuum components, all systems include base plate, interconnecting piping, point-to-point wiring as well as the control console.

Stokes provides you with all the extras, too: push buttons, pilot light, contactors, starters and gaging. In addition, your installation costs and start-up time are reduced since field assembly is limited to one vacuum connection and three utility connections.

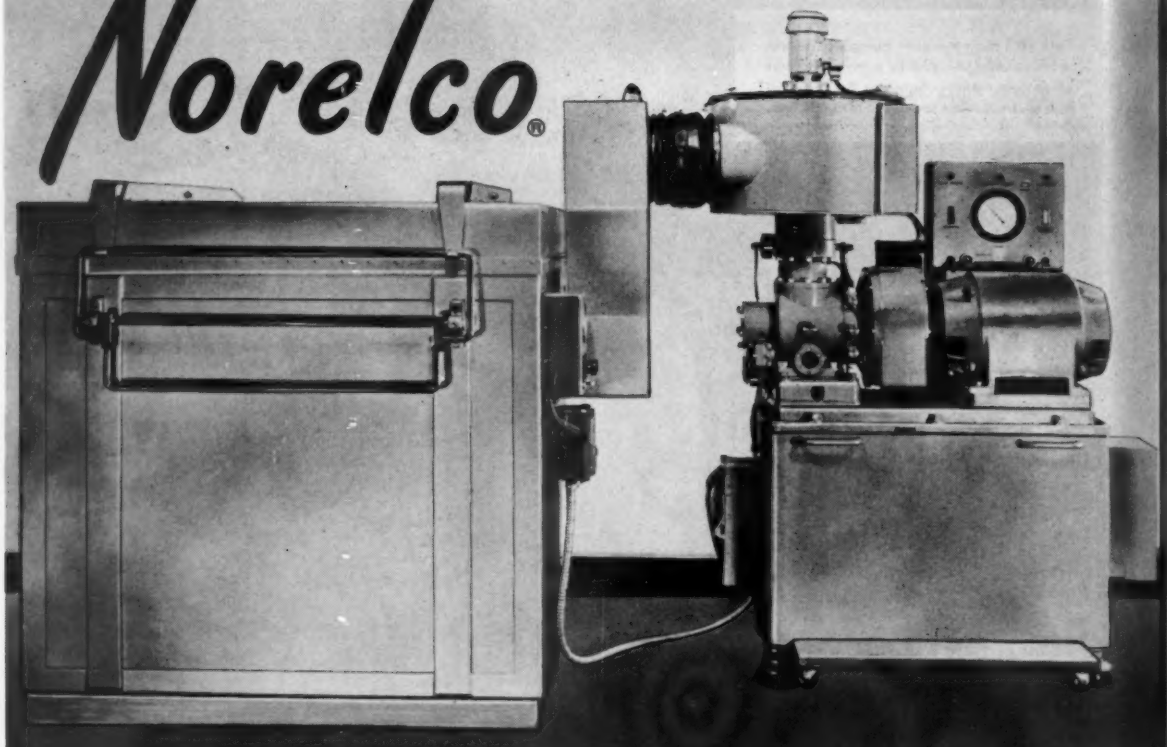
Why not let our Advisory Service study your particular requirements and make system recommendations. Today, while it's fresh in your mind, write to Stokes for complete information.

STOKES

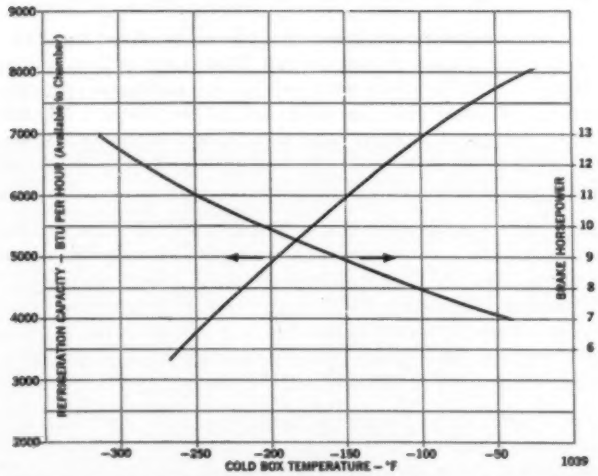
acuum Equipment Division

J. STOKES CORPORATION, 5500 Tabor Road, Philadelphia 20, Pa.

Norelco®



ENVIRONMENTAL CRYOGENICS



Refrigeration output available to the environmental chamber and brake horsepower requirements of the NORELCO Cryogenerator as a function of chamber temperature.

APPLICATIONS: Environmental testing ● Low temperature treatment and working of metals ● Preservation of biologicals and specimens — vaccines, sera, tissues, semen, etc. ● Shrink fitting ● Low temperature research ● Cold machining of metals and plastics ● Low temperature pulverization

REFRIGERATION CAPACITIES FROM 2,000 BTU/H TEMPERATURE CONTROL FROM −50 degrees F. to −265 degrees F. (±1 degree F.)

The NORELCO environmental systems provide refrigeration capacities between room temperatures and −265 degrees Fahrenheit. The temperature range from −50 degrees F. to −265 degrees F. is *controlled* within plus or minus 1 degree F. The NORELCO Cryogenerator, equipped with circulating head, provides deep-cooling and low temperatures for storage of materials and products in the environmental chamber. It is also easily converted for incidental production of liquid air.

The environmental chamber is a specially insulated storage chest used in conjunction with the Model A Cyrogenerator. This permits the production and maintenance of temperatures down to −265 degrees F. for environmental testing.

CRYOGENERATORS, INC.
Mendon and Angell Roads, Ashton, Rhode Island

Liquid Nitrogen generators and recirculating systems available for 70 degree Kelvin environmental temperatures

CONRAD Inc.

NEW Hyper Environment Chamber for Thermal Shock Tests

Model WD-585-50-50-50-50

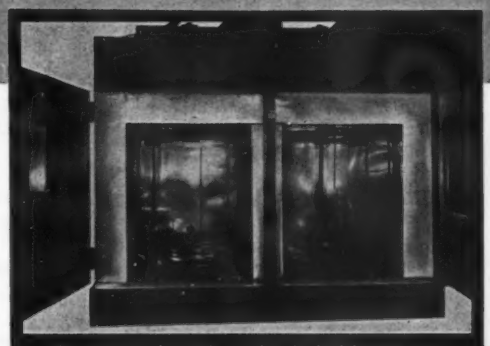
Simulates Missile Re-entry Problems

Recently completed for a government agency, this Conrad hyper environment chamber offers unusual flexibility. It may be used as a single large test chamber, or as two smaller chambers operating simultaneously at widely separated temperatures.

The main chamber is 9' wide x 5' high x 13' deep. A vertically-operating door divides the chamber into two sections when desired. Temperatures in each section are individually controlled from —100°F. to +500°F., with a broad range of humidity conditions. Special handling equipment rapidly shifts test components between sections to simulate missile re-entry conditions. The chamber is compact, considering the elaborate facilities it offers. All machinery is enclosed and self-contained.

Conrad is continually at work on custom chambers as well as stock models. Take advantage of this leadership. Call in Conrad on your next chamber requirements.

Write For Literature



Temperature in each section is individually controlled from —100°F. to +500°F. Test components are transferred from section to section through the use of special carts, rails, and turntables.

Controls include full instrumentation for each section as well as the complete chamber. Warning lights indicate position of dividing door, turntables, and carts.

SUBSIDIARY CRAMPTON MFG. CO.

CONRAD Inc.

HOLLAND, MICHIGAN

Attention

. . . if you make a move . . . be sure your copy of

Environmental Quarterly

goes with you—simply clip the address from the envelope in which this copy arrived, paste it here . . .

and fill in the following:

NAME .....

POSITION .....

NEW BUSINESS AFFILIATION

.....

NEW HOME ADDRESS .....

.....

.....

. . . and mail to Circulation Department, Environmental Quarterly, 252-46 Leeds Road, Little Neck 62, N. Y.

Environmental Quarterly, the pioneer scientific, industrial and service newsmagazine in the field of environmental simulation and testing, is independently published in January, April, July and October by Environmental Publications, Inc. Address all correspondence to: Martin Z. Post, Editor and Publisher, **252-46 Leeds Road, Little Neck 62, N. Y.** Telephone: **BA 5-0880.**

Guaranteed circulation: 6,000. Subscription: $4 annually in the United States and Canada, $5 elsewhere, except free of charge to **qualified individuals.** (Qualified individuals are scientists, engineers, educators, students and others in the U. S. who have a professional or business interest in environmental research, simulation, testing, production or sales. To qualify for a free "individual" subscription, send full name, position, company, nature of business and company and **home** addresses to the above address.) Single copy and back issues: $1.25 each, domestic and Canada; $1.50 elsewhere.

Quarterly welcomes competent expressions of opinion, but statements in its pages do not necessarily reflect its views. Right is reserved to extract portions of letters and other material submitted for publication. Correspondents must be fully identified, but names will not be published if such a request is made.

Printed by Princeton Printing Co., 176 Alexander Street, Princeton, N. J. Copyright © Environmental Publications, Inc., 1960.

ENVIRONMENTAL QUARTERLY

The Pioneer Space Age Publication of Environmental Simulation, Testing, Engineering and Equipment Manufacturing

October • 1960 Volume 6 • Number 4

Inside This Issue

ARTICLES

Exclusive Facilities for the Long Term 12
by Admiral John H. Sides, Commander in Chief, U. S. Pacific Fleet
A penetrating analysis of the "Path of the Environment"

'Search for Critical Reliability' 16
by C. C. Campbell, Convair-Astronautics
How the Atlas went through its environmental paces

Reliability Testing for Managerial Decisions 24
by Spencer A. Tucker, Martin & Tucker, Engineers
How to help make decisions that keep your business profitable, at any level of The Environment

DEPARTMENTS

EQ'S ALBUM OF PEOPLE, PRODUCTS, PLACES AND IDEAS 20-21
In Environments, too, a picture speaks a thousand words.

AROUND THE ENVIRONS 10
Notes of interest to those who work with environments.

ENVIRONMENTAL BUSINESS 38
The business side of creating environments.

ENVIRONMENTAL WANT ADS 34
An exclusive feature of EQ.

ENVIRONMENTS IN USE 32
A new feature of the new EQ.

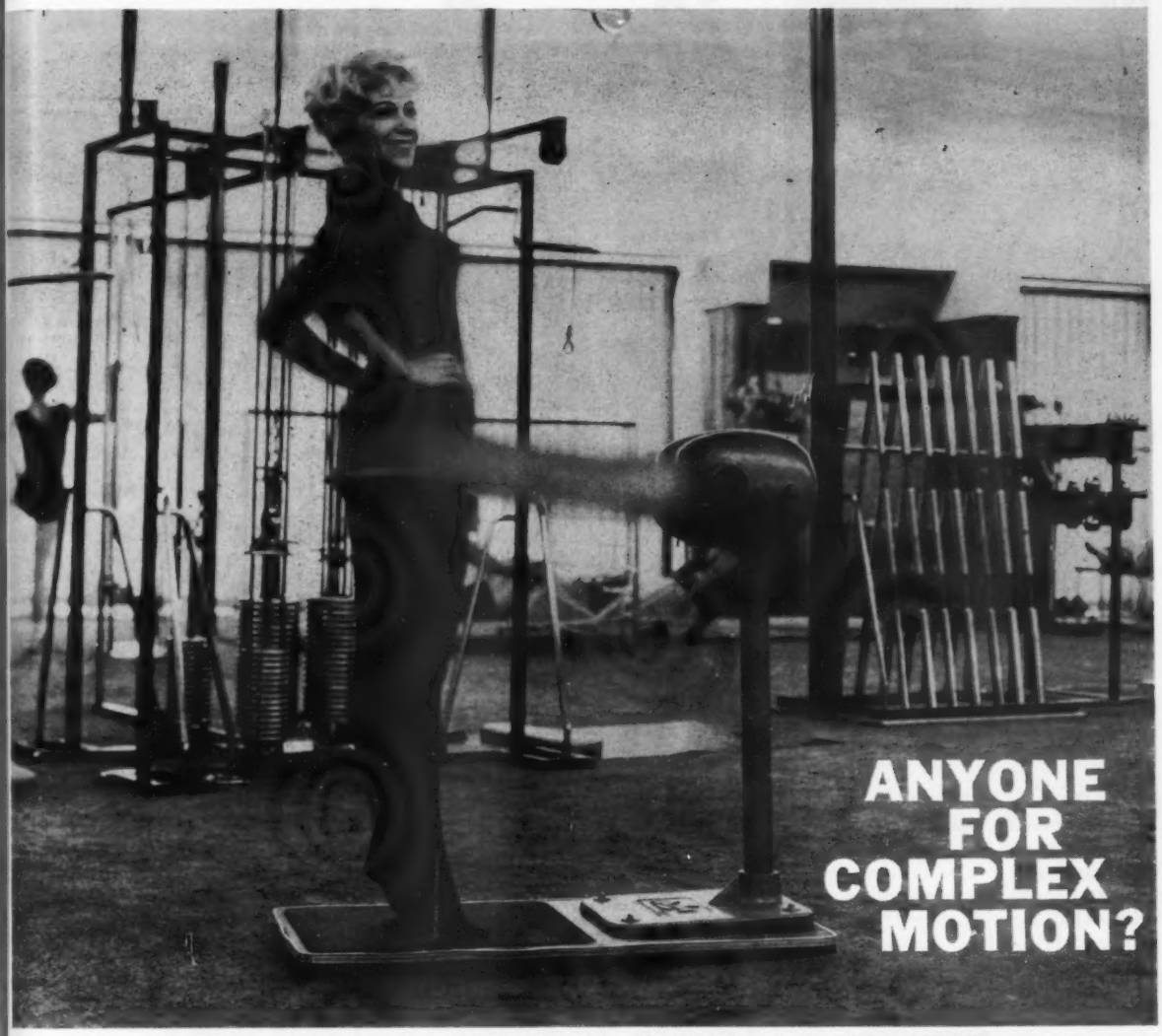
INDEX TO ADVERTISERS 8

LITERATURE FOR ENVIRONMENT 30
A digest of latest information material.

NEW PRODUCTS 34
Photos and text about devices to improve environments.

PEOPLE YOU KNOW 22
News of those in the changing environment.

POST SCRIPTS 6
A report from the editor of EQ.



ENVIRONMENTAL VIBRATION TESTING BY AEROTEST

From 160 db acoustic noise to 100g complex motion under a wide range of environmental conditions, AEROTEST offers manufacturers and users of aircraft and missile equipment the largest and most versatile vibration test facility available from any independent test laboratory. AEROTEST's experienced personnel are specialists in creative test engineering, and are trained to accurately apply and interpret test procedures. The vibration laboratory is equipped with modern equipment capable of handling a wide range of high performance vibration test requirements, encompassing the industry's immediate as well as future needs.

SINE WAVE VIBRATION

Frequency Range	5 cps to 3000 cps
Force Vector	5000 lbs.
Displacement	1.0 in. DA
Table Load, 10g Vector	500 lbs. max.
Side Table	54" x 54"

COMPLEX MOTION

Frequency Band	10 cps to 2000 cps
RMS Force	3000 lbs.
Peak Force	9000 lbs.
Maximum Acceleration	100g's peak
Side Table	54" x 54"

COMBINED ENVIRONMENT VIBRATION

Altitude	0 to 250,000 ft.
Temperature	—150°F to 300°F
Humidity	5% to 95%

ACOUSTIC NOISE TESTING

Sound Volume	up to 160 db
Frequency	10 cps to 20,000 cps

Technical and cost proposals for all testing programs submitted without obligation. AEROTEST provides complete functional and environmental testing of electronic, mechanical, pneumatic, hydraulic, avionic, and fuel systems and components. Write today for descriptive brochure of AEROTEST's facilities.

Side Table Facility, measuring 54"x54", for Sine Wave and Complex Motion Vibration Testing.

LOW TEMPERATURE
HIGH TEMPERATURE
FUEL RESISTANCE
ENVIRONMENTAL VIBRATION
CONTAMINATED FUEL
ROCKET AND MISSILE PROPELLANT FLOW TESTING
ACCELERATED CORROSION
RADIO INTERFERENCE
RAIN
SUNSHINE
ENDURANCE
EXPLOSION
NOISE LEVEL
SHOCK
FUNGUS
HOT FUEL FLOW
HIGH ALTITUDE
SAND AND DUST
HUMIDITY
SALT SPRAY
IMMERSION
ACCELERATION

AEROTEST LABORATORIES, INC. *Comac Road, Deer Park, L.I., N.Y.*

EXCLUSIVE ENVIRONMENTAL TEST FACILITIES

for electronic, electrical, electro-mechanical components and sub assemblies

EXCLUSIVE EXPERIENCE *and unique combination of Facilities offer big savings in time and money. For example, Rototest offers 6000 amp. of regulated 28 Volt D.C. . . . poly-environmental facilities . . . equipment to perform valid random vibration tests. Fast service on any combination of over 160 Mil Spec qualifications — 32 with ASESA recognition for QPL testing.*

PROVEN CAPABILITIES — *More than 150 industrial and military repeat customers including Aerojet-General Corp., Autronics Corp., Beckman Instruments, Inc., Consolidated Electrodynamics Corp., Haydon at Torrington, Hughes Aircraft Co., Lockheed Aircraft Corp., North American Aviation, Inc., The Martin Co., Olin Mathieson Chemical Corp., RCA, Wright-Patterson Air Force Base.*

GET YOUR ROTOTEST *Facilities Brochure now. Write or phone J. Davidson. Please indicate areas of interest or specific problems.*

ROTOTEST
LABORATORIES, INC.
. . . as near as your telephone
2803 Los Flores Blvd., Lynwood, California

leader in solving unique test problems

Post Scripts

A year ago, coincident with the turn of the decade, *Environmental Quarterly* asked a question, to wit: "Whither goest, Environment?" Replies from all walks of the environmental discipline have appeared in these pages under the general heading of "Path of the Environment."

In this issue, Admiral John H. Sides, the new commander-in-chief of the Pacific Fleet, provides a fitting climax to the "Path" series with a discussion of "Exclusive Facilities for the Long Term." It is commended to all who work in The Environment.

Although Admiral Sides' remarks bring the "Path" series to a formal close, we have no intention of dropping the subject. Projecting the future is not just a guessing game, it is essential to orderly, rational development. Yesterday's "pie in the sky" is tomorrow's reality, especially in a field as vital as that in which we serve.

Proof? Only yesterday "orbital simulation" was a hope and a dream, and the number of truly orbital simulators in existence could be counted on a couple of fingers. One such pioneering unit is the Bemco-Lockheed chamber described in this issue's "Environments in Use" department under the heading "Simulating Radiation in Orbit."

Moving Into Orbit

The past year has seen important advances in orbital simulation research and Quarterly plans a report on this in the near future. In a wide-ranging review of the environmental industry in its Oct. 10, 1960, issue, *Barron's*, the financial weekly, cites the work of Tenney Engineering, Inc., in this area as significant to the business community.

The article, by Dana Thomas, was *Barron's* second look at The Environment in less than two years, itself testimony to the explosive growth of our industry.

Environments Abroad

As the domestic environment rushes into space, there is a tendency to overlook what is being accomplished abroad. Robert H. Brown, Tenney's vice president for sales, made a two-week tour of the European Environment in September and returned to report that he found that "testing procedures at the levels at which they are working are just as high as ours, and their specs are just as advanced."

Brown

Because countries like France, England and West Germany are not as heavily involved in the space race, "we are definitely more advanced in such areas as simulation of solar radiation and cryogenic pumping," he said, but added: "I wouldn't underestimate what is happening there, although it may be on a smaller scale than in the United States."

Mr. Brown said he was especially impressed by advances in environmental aeromedical testing in the realm of manned aircraft.

Nevertheless, he said, European specialists have much to offer the U. S. One purpose of his trip, aside from meeting with his company's sales representatives abroad and conferring on specifications for pending business, was to consult with European scientific personnel in the art of solar simulation. He said these discussions were "most satisfactory."

Consumer Goods Testing

The French, Mr. Brown said, do a considerable amount of environmental testing of consumer goods, especially in the appliance field. He said a similar interest exists in Italy and the Scandinavian countries, and that Tenney's representatives, Deutsche Waggon und Machinenfabriken, of West Germany, are selling combined vibration-temperature-altitude chambers.

Mr. Brown found a keen environmental interest but a relatively small equipment manufacturing industry in England.

"They do not specialize in environmental equipment as we do and have no standard lines," he said, "but they are most capable of turning out chambers on a custom basis. However, when they want something of an advanced nature from a reputable source, they turn to the United States.

"The English do, for example, manufacture vibration equipment. But apparently nobody in England is offering vibration systems as big as U. S. companies offer.

"Nevertheless," the Tenney executive added, "the need for environmental facilities is growing abroad as they get more and more into space and for industrial purposes, and we look for increased business from overseas."

Two Obstacles Cited

Mr. Brown cited two obstacles in selling to Europeans: national pride, which impels them to buy at home if they can, and the problem of monetary exchange.

He said he found a great deal of interest in American production methods.

For All Who Manage

Production, costs and, inferentially, profits are of primary concern to everyone in The Environment. Quarterly has left the beaten path, therefore, to present, in this issue, "Reliability Testing for Managerial Decisions." It offers a unique approach that should interest everyone whose effort contributes to cost—meaning everyone—in an extremely cost conscious industry.

Environmental Education

As much as anyone, *Environmental Quarterly* has been preoccupied with the subject of education in The Environment. It was a pleasure, therefore, to read an article stressing education by William B. Brierly in the October, 1960, issue of the

NOISE LIKE YOU NEVER HEARD AT HOME!

In fact, we know of no other available acoustic noise-test facility with sound intensities to 150 db through a frequency range of 20 to 20,000 cps with a working volume of 15 cu. ft. This is only one example of the large number and variety of test chambers and facilities in Associated Testing Laboratories' brand new 30,000 sq. ft. plant in Wayne, N. J., and 10,000 sq. ft. facility in Orlando, Fla.

A few more examples of the tremendous scope of Associated's environmental test equipment:

(1) A 5,000 force-lbs. sine and random vibration capability with latest automatic equalization equipment.

(2) A 12,500 force-lbs. sinusoidal vibration capability.

(3) Shock capabilities including a 1,200-lb. MIL-S-4456 sand-drop machine; and a MIL-S-901 Navy Shock Test Machine.

(4) A variable-pulse saw-tooth or square wave shock machine.

(5) Chamber capabilities through a 12' x 12' x 11' High-Low Temperature Humidity Chamber. But add to all these facilities complete instrumentation for testing and recording almost all equipment—including digital reading and print-out equipment specially designed for component testing.

Remember Associated Testing is open 24 hrs. a day and your engineers are welcome to be on hand while tests are in progress.

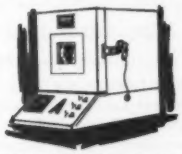
ASSOCIATED TESTING LABORATORIES, INC.

Testing Divisions

121 Route 23
Wayne, New Jersey
Telephone: CLifford 6-2800
TWX: LT FS NJ 943

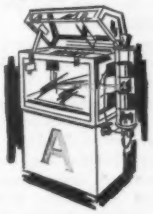
1112 Solana Avenue
Winter Park (Orlando), Florida
Telephone: Midway 4-1800
TWX: WN PK 7210

Manufacturers of:



ECON-O-LINE Low-High Temperature Test Chamber Liquefied CO_2

Low-High Temperature Test Chambers Liquefied CO_2 or Cascade Refrigeration



Salt Spray Chambers (all lucite construction)

Newsletter of the NAS-NRC's Prevention of Deterioration Center.

Mr. Brierly, who is chief of logistics applications, Environmental Protection Research Division of the Quartermaster Research and Engineering Center, Natick, Mass., cited "establishing curricula in colleges and universities leading toward degrees in the field" as one of four needs of environmental engineering.

"Much has already been accomplished toward attaining the first three objectives," Mr. Brierly wrote, listing them as: defining the field, preparing adequate documentation in the form of handbooks, journals and texts, and obtaining recognition from other professional groups and governmental bodies.

An Environmental Curriculum

In connection with his article, Mr. Brierly presented a possible curriculum for the environmental engineer, prepared by Prof. Harold C. Jones, of the University of Maryland, who was the first president of the Institute of Environmental Sciences.

Aside from general liberal arts subjects, such as English and history, and general scientific subjetcs, such as math and chemistry and physics, Prof. Jones' curriculum contained the following:

Sophomore year—basic electrical engineering. Junior year—fluid mechanics, introduction to nuclear technology, thermodynamics, electronics, communication and heat transfer. Senior year—radio engineering, transients, refrigeration, applied elasticity, kinematics, feedback control system and transistors.

A fifth year of still more advanced courses is also suggested as necessary for the making of an environmental engineer.

EQ's ADVERTISERS

Acton Laboratories, Inc.	37
Aerotest Laboratories, Inc.	5
American Research Corporation	30
Associated Testing Laboratories, Inc.	7
Avco Corp., R. and A. D. Division	19
Barry Controls, Inc.	Inside back cover
Beach-Russ Company	40
Bemco, Inc.	26
Cardox Division, Chemetron Corporation	27
Cincinnati Sub-Zero Products	33
CompuDyne Corporation	22
Conrad, Inc.	3
Consolidated Vacuum Corporation	8
Cryogenerators, Inc.	2
Endevco Corporation	Inside front cover
Environmental Equipment Institute	28
Environmental Want Ads	34
Gulton Industries, Inc.	15
Harris Manufacturing Co., Inc.	11
L.A.B. Corporation	28
Ling Electronics, Division of Ling-Altec Electronics, Inc.	Front cover
Optron Corporation	18
Pure Carbonic Co., Div. of Air Reduction Co., Inc.	9
Research Incorporated	31
Rototest Laboratories, Inc.	6
Rucker Company, The	13
Standard Cabinet Company, Inc.	35
F. J. Stokes Corporation (Vacuum Equipment Div.)	1
Tenney Engineering, Inc.	Back cover
Thermoseal Glass Corporation	34
United Aerotronics Corp.	29
United States Testing Company, Inc.	14
Varian Associates (Vacuum Products Div.)	23

IN THE LABORATORY

ON THE PRODUCTION LINE

TEST SHOCK WITH CVC HYGE

You can produce and reliably repeat today's widest range of shock waveforms—half-sine, ¼ cosine, sawtooth, square and combinations—with CVC HYGE.

You'll find a HYGE model to meet your requirements for laboratory *or* production line use. With HYGE, you'll have a compact source of stored energy at your fingertips for producing shock waveforms to meet most test specifications—and at a cost of only pennies per test. As new requirements develop, HYGE lets you adapt to them by adding a simple metering pin.

HYGE 6000 — Large laboratory model. Thrust capacity to 40,000 lbs.; acceleration, 2000G.

HYGE 3000 — Small laboratory model. Thrust capacity to 10,000 lbs.; acceleration, 500G.

NEW PRODUCTION LINE HYGE — Thrust to 15,000 lbs.; acceleration, 100G. Provides most widely specified shock pulses: MIL-E-5272A (11 ±1 ms half-sine) and Ramo-Woolridge (6 ±0.5 ms Sawtooth). 5 tests in 5 minutes at less than 5¢ per test.

WRITE for HYGE Bulletins. Or, outline your requirements and ask for a specific recommendation.

Consolidated Vacuum Corporation

ROCHESTER 3, NEW YORK

A SUBSIDIARY OF CONSOLIDATED ELECTRODYNAMICS/BELL & HOWELL

400° above to 110° below in minutes*

TEST CHAMBER TEMPERATURE

...WITH PURECO CO_2 "BLAST COLD"

CO_2 is Best... For Test

The Pureco CO_2 *Blast Cold* process is a simple, efficient low cost method of refrigeration for low temperature test chambers. Direct injection of Pureco carbon dioxide liquid drops temperatures to required levels in a fraction of the time required by mechanical units. Cooling is produced by vaporizing a jet of liquified CO_2 directly into the chamber.

Extremely close tolerances maintained.

Temperatures are automatically controllable within limits closer than government testing standards require. Pureco CO_2 *Blast Cold* starts immediately at maximum rate the instant valves cycle on—stops the instant CO_2 flow is cut off.

Low capital expense... low operating cost.

No heavy investment required for equipment . . . installation is simple and space saving. Equipment is trouble-free. There is virtually no possibility of mechanical failure.

Direct or Indirect Cooling.

CO_2 liquid may be injected or DRY-ICE placed directly in a chamber—used to cool a circulating air stream or a non-freezing solution for indirect cooling.

Have a trial Blast Cold demonstration.

Pureco would like to demonstrate *Blast Cold* to you at *your* plant under your working conditions, with no obligation on your part. Pureco's Technical Sales Service will provide any assistance you need to help solve your low temperature testing problems.

**Actual Pureco Test*

PURECO CO_2

PURE CARBONIC

Pure Carbonic Company, A Division of Air Reduction Company, Incorporated
Nation-Wide Pureco CO_2 Service-Distributing Stations in Principal Cities
General Offices: 150 East 42nd Street, New York 17, N.Y.

AT THE FRONTIERS OF PROGRESS YOU'LL FIND AN AIR REDUCTION PRODUCT

AROUND THE ENVIRONS...

Shock, Vibration Symposium Is Set

Major discussion areas of the 29th Symposium on Shock, Vibration and Associated Environments have been announced by the Office of the Director of Defense Research and Engineering. The symposium will be held Nov. 15-17 at the Naval Supply Center, Oakland, Calif.

Rear Adm. G. L. Russell, commandant of the 12th Naval District, will give the welcoming address at the opening session, over which Dr. W. W. Mutch, head, Centralizing Activity for Shock, Vibration and Associated Environments, will preside.

E. Finley Carter, president of Stanford Research Institute, will then speak on "Democracy, a Flexible System under Stress," and Herman Kahn, of The Rand Corporation, will discuss "Implications of Various Concepts of Maintaining Deterrent Capability." A speaker yet to be announced will deliver a paper on the environmental problems raised by the concepts discussed by Mr. Kahn.

Other Topics Listed

Afternoon sessions on opening day will hear papers dealing analytically and experimentally with underground free field effects produced by an explosive force and with environmental problems in ships. Session chairmen have been listed as Dr. Harold Brode, of The Rand Corporation, and Harry Rich, David Taylor Model Basin, respectively.

Wednesday, Nov. 16, sessions will be concerned with dynamic soil-structure interaction (Dr. George Young, AF Ballistic Missile division, chairman); with the "why," "when" and "how" of testing (Joseph Kaufman, office of the Army's Chief of Ordnance, chairman); design of hardened structures (chairman to be announced), and establishment of test levels from field data. The last is being designed for maximum audience participation.

The final days topics will cover simulation of blast-induced environments (Eric Wang, Air Force Special Weapons Center, chairman); equipment and techniques for improved data analysis (Dr. Charles Morrow, Space Technology Laboratories, chairman), and responses to shock and vibration excitation and applications to design (Dr. Reinier Beeuwkes, Watertown Arsenal, chairman). Another session was to be scheduled for Thursday afternoon.

A housing bureau to handle hotel reservations has been organized at Room 300, 61 Grove St., San Francisco 2, Calif.

Military Electronics Meet Set

The IRE's Winter Convention on Military Electronics will be held Feb. 1-3, 1961, in Los Angeles. Deadline for 100-word abstracts and 500-word summaries is Nov. 15. They should be sent to Dr. John J. Myers, Hoffman Electronics Corp. 3717 S. Grand Ave., Los Angeles, Calif.

Combined Environments Testing for Men, Too

The most important component of all —man—is being put through environmental test paces at Boeing Airplane Company's space medicine section, Seattle, in anticipation of manned flight beyond the atmosphere.

In Boeing's stratotrainer, a volunteer is subjected to three simultaneous body stresses, intense heat, high level noise and depressurization, astronauts are expected to experience when they blast off.

In another, related experiment, Dr. Romney H. Lowry, manager of the medicine section, has spent several hours in an air-tight chamber supplied with oxygen converted from carbon dioxide by growing green algae. These minute plants may be a source of a balanced atmosphere in space travel.

Among the Sales Reps

UNITED STATES TESTING COMPANY. INC., has appointed Aertronic Associates, Inc., 324 Salem Ave., Dayton, Ohio, as sales representative for Ohio, Indiana, Michigan and Kentucky. John D. Schram is the account executive

COMPONENTS FOR INDUSTRY, which handles environmental test equipment in upstate New York, has opened a new office in Fayetteville. Gunnar Hanson, a partner of the firm, is in charge. CFI's Tonawanda office has moved to Buffalo, under the management of Richard Moran.

Avnet Electronics Corp. has been selected as national distributor for all types of trimmers produced by TECHNOLOGY INSTRUMENT CORPORATION OF ILLINOIS, of Franklin Park, Ill.

C. F. Russell Co., Bay Shore, N. Y. and Catonsville, Md., is the new representative for WYLE MANUFACTURING CORP. environmental equipment in New England and Atlantic seaboard states.

Deadline for IES Papers Is Dec. 30.

The deadline for finished papers to be delivered at the annual national meeting of the Institute of Environmental Sciences in April is Dec. 30, according to David Askin, co-chairman of the technical program. Raymond Yaeger, the IES' fiscal vice president, is the other technical program co-chairman.

The technical program will run three days at the Sheraton-Park Hotel, Washington, April 5-7. At the same time, there will be a trade and product exhibition devoted to the same themes: ground environments, marine or seaborne environments and aerospace environments.

Abstracts of papers were due Sept. 30. Communications relative to presentation of papers should be addressed to Mr. Askin, Chief, Test and Evaluation Branch, 1730/230, Army Ordnance Arsenal, Frankford, Philadelphia 37, Pa., or to Mr. Yeager, Missile Division, Chrysler Corp., P. O. Box 2628, Detroit 31, Mich.

Gaudet Named President Of Boston Area Chapter

Joseph J. Gaudet, who heads the environmental laboratory at Sanders Associates, Inc., Nashua, N. H., has been named president of the Boston Area chapter of the IES. He succeeded Gerhard Doering, who was moving to the Philadelphia area.

Gaudet

In the resulting realignment of officers, Ralph Marcus, group head of test engineering in the Airborne Equipment division of Raytheon, in Sudbury, Mass., stepped into the vice presidency. He also continues as membership chairman.

The new officers were named at a meeting of the chapter's executive committee after a regular chapter meeting August 16 at Avco Research & Advanced Development Div., Wilmington, Mass. The following appointments were made to fill unexpired terms:

Secretary, Elmo Pacini, group head in the environmental laboratory at Raytheon-Sudbury; national director, Dorman Priest, of Ling Electronics, Winchester, Mass., and publicity chairman, David E. Hemingway, manager, environmental engineering laboratories, Richard D. Brew and Company, Inc., Concord, N. H.

Continuing in their respective offices are Peter Fowler, department head of the environmental laboratory in Raytheon's Components division, Newton, Mass., who is the chapter's program chairman, and Bernard Kinney, Itek Corporation, Waltham, Mass., treasurer.

N. Y. Chapter to Meet December 8

The annual symposium of the New York I. E. S. chapter will be held Thursday, Dec. 8, at the Henry Hudson Hotel, New York. The theme will be "Man's Environment in Outer Space."

The industrial exhibit that has accompanied similar chapter meetings in the past is not scheduled to be held this year. A "proceedings" is to be published, however.

Jesse Markson, of E. R. A. Incorporated, symposium chairman, has listed some of the papers to be presented as follows:

"Space Flight Environmental Effects," Robert J. Woodcock, assistant chief, Aero Space Mechanics branch, Flight Control Laboratory, Wright Air Development Division.

"Solar Radiation," Dr. Marshall Wernick, Space Technology division, Guardite division of American Marietta Co.

"Magnetic Effects in Space," John McCarthy, Sperry Gyroscope Co.

"Gravitational Effects In Space," Dr. Siegfried Gerathewohl, Chief of Operational Development, Office of Life Sciences, National Aeronautics and Space Administration.

"Human Physiological Stresses at High Altitude," Arnold Beck, Design Safety and Reliability section, Republic Aviation Corp.

"Food Supply in Space," Harold Rind and W. Taufman, Applied Research and Development division, Republic Aviation Corp.

"Space Medicine," Dr. Robert Del Vecchio, aviation physiologist, Human Factors division, Grumman Aeronautical & Engineering Corp.

"Galactic Astronomy in Relation to Space Travel," Dr. Lloyd Motz, professor of astronomy, Columbia University.

"Life Beyond The Earth," Dr. W. Vishniac, Yale University.

Chapter Sponsors Penn State Course

A 12-week lecture course on the Environment and environmental engineering is being given at Pennsylvania State University, in Philadelphia, in cooperation with the Mid-Atlantic Chapter of the I. E. S. Held on Monday nights, the sessions began Sept. 19 and run through Dec. 5.

The lecture subjects are:

"Philosophy of Environmental Testing, David Askin, Pitman-Dunn Labs, Frankford Arsenal, Philadelphia.

"High and Low Temperature and Humidity Environments," Fred Hermann, Tenney Engineering, Inc.

"Solar Radiation Environments," John Gelhard, Missile and Space Vehicle division, General Electric Co.

"Sand, Dust, Fungus and Corrosion Resistance," Mark Sigismund, Pitman-Dunn Labs.

"Outer Space Environment," Peter Marfone, MSVD, General Electric.

"Nuclear energy, Environment and Instrumentation," Dr. Alan E. Surosky, General Testing Laboratories.

"Vibration Testing Fundamentals," Robert M. Jones, Tek-Sel, Inc.

"Modifying Environmental Conditions by Use of Shock and Vibration Isolators," Jesse Markson, E. R. A. Incorporated.

"Instrumentation for Dynamic Measurements," Dr. Irwin Vigness, U. S. Naval Research Laboratory.

"Shock Tests and Shock Spectra," Max Lazarus, Barry Controls, Inc.

"Random Vibration," Dr. Robert Mains, Knolls Atomic Laboratory, General Electric.

"Acoustic Noise Environment," E. J. Kirchman, PAM Associates.

Some Big Numbers From Washington

NASA will launch 17 earth satellites and four lunar and interplanetary probes in fiscal '61, according to the Aerospace Industries Association. Some $600,000,000 is on tap in the same period for accelerating the space program, AIA says.

From other sources come figures that show that the Defense Department's R&D effort has doubled in three years. In FY 1956 $2,404,000,000 went for this purpose, while in FY '59 the expenditure was $4,898,000,000.

PRECISION CONTROL + SUPER THERMAL CAPACITY

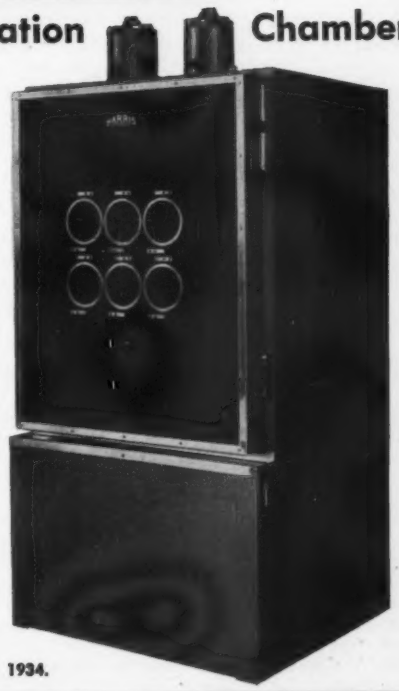
with New Harris Temperature Calibration Chamber

Point control of ±.1° C. in repeatability, speed of response, and on-off differential is provided by this new Harris Environmental Chamber, Model 6L-A2-20. 6 cu. ft. chamber with temperature variation of less than 1° C. Temperature range of —20° C. to —85° C. Complete recovery in ten minutes with 1000 BTU product load at —65° C.

Air circulation positively controlled by two blowers in a specially designed plenum chamber. Door accommodates a wide variety of fixtures, or may be inexpensively modified for any requirement. Door and cabinet trim, drip tray, and interior all of #304 stainless steel.

Machine fully protected against high pressure build-up or loss of refrigerant should electric power or water fail. Starts automatically when services are restored.

Users report that this machine is setting new standards for accuracy in temperature calibration. Write to see how it can do the same in your plant.



HARRIS MANUFACTURING CO., INC.

312 River St., Cambridge 39, Mass.

MEMBER OF ENVIRONMENTAL EQUIPMENT INSTITUTE

Pioneer in refrigeration service, engineering, and manufacturing since 1934.

Path of the Environment:

Exclusive Facilities for the Long Term

"Reliability is an engineering job which must start at the very inception of a project and never be allowed to slacken. Any attempt to achieve it as an afterthought will result in wasted man-hours, wasted dollars, wasted range time and many heartaches."

by Admiral John H. Sides

Commander in Chief
U.S. Pacific Fleet

AS A YARDSTICK against which to measure our technological progress since about 1945, it might be well to step back and recall the state of the art of those times in most fields contributing to weapons systems. At the end of World War II, when our missile developments really began taking shape:

—there only existed the most meager information on supersonic flight.

—the turbojet was an infant.

—no ramjet had ever developed a margin of thrust over drag in supersonic flight.

—large grain solid propellantry was a new field.

—radars, although they had had a terrific effect on the outcome of the war, were really relatively new.

—the electronics industry, when viewed in the light of the present day and in the light of the demands which missiles would make, was also in its infancy.

—no one had a very good idea of how to design and produce a radome.

Ignorance of Operating Environment

One of the most serious deterrents to satisfactory progress in the early days was the almost total lack of precise knowledge concerning the operating environment in which each component would be required to operate. This lack persisted for more years than we like to contemplate, and attempts were even made to put certain projects into limited service use before the environments were well understood. Needless to say, these attempts now represent a rather dark chapter in the history of the progress of the guided missiles.

In the early days of missile development there was a widespread tendency to concentrate on flight testing first, in an effort to gain time, with the thought that building reliability into a missile system was something which could wait until the production, or at least the pre-production, phase. I can think of no philosophy which has had a more serious effect on our progress. Initial flight test phases of several missiles were beset with casualty after casualty during the periods when time was of the essence. The result was a terrible waste of much scientific and engineering effort, millions of dollars and much precious time.

We now know that the initial flights, when we are trying to demonstrate feasibility of the systems, are perhaps the most important of all, so that there is a need to do everything within our power to insure that casualties do not occur. If there is ever a time for over-designing in the interest of real reliability it is in the initial flight test stage when each flight is so vital. It is absolutely essential to obtain full environmental information in early flight tests before designs of ultimate components can be firmed up with any assurance that the requisite reliability will be obtained.

No Easy Road to Reliability

There are no tricks, no cheap ways, no easy roads to reliability. Attaining it is, in the final analysis, an engineering problem which requires the last word in thoroughly coordinated effort to produce a proper design, followed by production and inspection techniques that will assure translation of the results into the end product. The answer is not in shaking a component to death on a shake table or cycling it to death in a hot and cold chamber during acceptance testing. These techniques are absolutely essential in assisting the engineers to design properly in the *first* place; and flight testing is absolutely essential as a final check to assure that the design is a sound one.

But once a good design has been attained—so that components are not required to operate close to ultimate limits, so that mechanical strengths are sufficient to withstand accelerations and vibrations encountered in flight, so temperatures do not exceed reasonable limits—then there

This article is based on an address Admiral Sides delivered last Spring at the Boston IRE Section's Joint Conference on Military Reliability and Quality Control Requirements—and on a distinguished career as a pioneer Navy missile man. A 1925 graduate of Annapolis (with an M.S. in engineering from the University of Michigan), he spent many years in ordnance and gunnery work. In 1942 he became chief of the ammunition and explosive section in the R & D division of the Bureau of Ordnance, directing development of new and improved fuzes, projectiles and more powerful explosives for underwater munitions. After another tour of sea duty during the latter half of World War II and other assignments, Admiral Sides was assigned as deputy to the director of guided missiles in the office of the Chief of Naval Operations, and ever since has held key posts in the Navy's missile programs, including director of guided missiles for 3½ years (as a rear admiral). In January, 1956, he became the first flag officer to command a guided missile force at sea when he took over the newly organized Cruiser Division SIX and pointed the way for the large number of missile ships to join the fleet. Later that year Admiral Sides was named deputy to the special assistant to the Secretary of Defense for guided missiles. Promoted to vice admiral in 1957, he became director of the weapons systems evaluation group in the Office of the Secretary of Defense, the position he held when he addressed the Boston meeting. On Aug. 31 last he assumed the duties of commander-in-chief, Pacific Fleet, with the rank of full admiral.

Sides

is an excellent chance that we shall be well on the way to achieving true reliability in the weapon we give the soldier, sailor, marine and airman to do his vital job.

If we are to achieve true reliability there never will come a time when the design engineers can turn a job over to the production people and wash their hands of it. It is necessary for the production engineers to become heavily involved at a very early stage, but the designer and production engineer must work hand in hand from that point on. There must be effective and immediate feedback from subcontractor organizations, from the assembly lines and from the field, so that every malfunction, regardless of where it occurs or how serious it is, becomes known immediately to all echelons of the design-production team. Only in this way can we initiate immediate steps to cure the ills before they snowball into a crisis.

Management's Support Essential

And it should be stressed that the finest organization in the world is not likely to achieve the desired results unless top management thoroughly understands the problem and gives unceasing support and understanding to those who are devoting their full time to achieving reliability.

To the user, it matters little that a missile checked out satisfactorily at the end of the assembly line, was accepted by the government inspectors and was paid for. What concerns him primarily is whether it will perform properly when he fires it, long after the final acceptance test.

Although basic philosophies will not vary greatly from Service to Service, working environments and facilities will vary to an extent which may dictate quite different procedures. For instance, field armies may experience conditions of dust, sand, mud and weather quite different from those of the Air Force operating from air bases, or the Navy operating at sea where missiles must stand salt spray and blue water, but where workshops will be clean and well equipped.

It is a sobering thought that what might be considered a minor derangement in a piloted aircraft—often susceptible to adjustment and correction in flight by the crew—would in a guided missile be a catastrophe. This is the key reason why reliabilities that might be acceptable in almost any other industry are unthinkable for guided missiles.

The State of the State-of-the-Art

One sometimes hears that since it takes so long to bring a weapons system into fully operational status we simply must always be anticipating the state-of-the-art when we specify a system. This, I think, may be a snare and a delusion. In many cases the very reason for its taking so long to bring a program into fruition is this attempt to strain the state-of-the-art.

To put the finger on the responsible party usually takes two fingers. First, the Services are prone to levy requirements and lay down specifications and time scales which simply are not within the state-of-the-art for accomplishment. This initiates a chain reaction in which prospective bidders are prone to be overly optimistic, realizing full well that a realistic proposal may not get serious consideration. Then, after the project gets well under way, it is perfectly natural for the contractor to propose further refinements and improvements.

The result of this series of actions and reactions is usually heavy over-runs insofar as the fiscal picture is concerned, as well as stretchouts and delays in completion of the project. Sometimes, when difficulties are encountered, it appears at first blush that they can be cured by including trick circuitry, additional components of a specialized nature and the like, and these remedial measures are incorporated at the expense of complexity rather than get-

400,000 G POUNDS
ACCELERATION TESTING with RUCKER CENTRIFUGES

Large Rucker Centrifuge Acceleration Test Machines provide accurate environmental testing of components, instruments and complete assemblies for military facilities, missile manufacturers, allied industries participating in the rocket and missile development program.

RUCKER FEATURES

- Proven design offers greatest range of simulated acceleration and combined environmental tests
- Safety factor of 5
- Counter-rotating specimen platform
- Test chambers for temperature, humidity, altitude and vibration
- Electrical slip rings
- Complete interlocking system for fail-safe operation
- Maximum accuracy through high inertia design and precision control system
- Hydraulic-pneumatic rotary joints
- Closed circuit TV
- Wave guides for all applications

Ideally suited for exacting laboratory testing or production test procedures, Large Rucker Centrifuges are available in six standard models accommodating specimen weights from 300 to 9,000 pounds and with centrifugal capacities to 150 G. Larger models custom-designed to meet special needs.

Small Rucker Centrifuges also available.

For full details, write today to

THE RUCKER COMPANY Since 1941

4700 San Pablo Avenue • Oakland 8 • California

ATTENTION: Openings now for Qualified Engineers—for Design and Sales

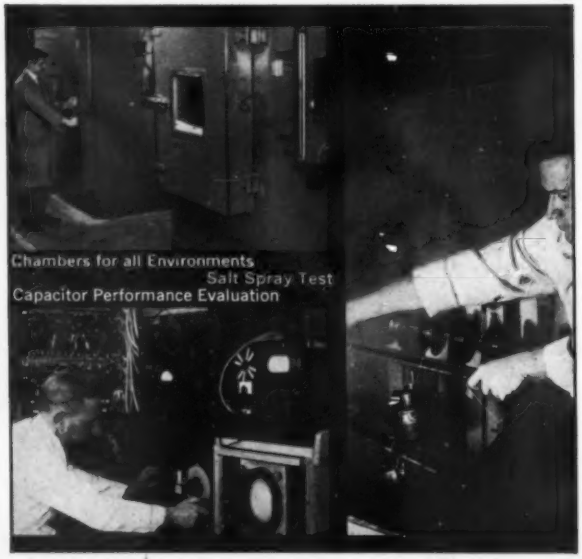
United States
Testing Company
offers

COMPLETE ENVIRONMENTAL FACILITIES

Use our facilities to evaluate product operation under all environmental conditions. Get automatic alternating cycles of contrasting conditions... remote control of product operation by mechanical, electrical, or hydraulic means... and a wide range of supply voltages and frequencies. Simulate high-low temperatures, humidity, altitude, explosion, immersion, salt spray, sand and dust, rain, fungus, vibration, shock, acceleration, etc. Test to military, government, and commercial specifications.

Complete facilities in the fields of chemistry; metals chemistry; metallurgy; physical testing of materials; engineering analysis of mechanical, electromechanical and electronic devices; site inspection; package testing; psychometrics and certification services for product quality control.

22



Send for free bulletin describing our services.

United States Testing Co., Inc.
1415 Park Avenue, Hoboken, N. J.

Branch Laboratories
Boston · Brownsville
Dallas · Denver
Los Angeles · Memphis
New York · Philadelphia
Tulsa

The World's Most Diversified Independent Laboratory.

ting down to the nub of the problem and finding a simpler, yet less apparent, cure.

Fiscal Feasibility, Too

One of the factors which in this day and age make it so difficult to do long-range planning is that of fiscal feasibility. The same lack of realism which I have spoken of in connection with the state-of-the-art is usually apparent in original cost estimates. It is probably not uncommon for the final tab for developing, producing and placing a planned force level in the field to exceed the original estimate by a factor of something on the order of four.

When we postulate a national defense posture of several years hence, it is absolutely necessary that our predictions of over-all budgetary requirements be much better than this. Unless and until we can be more realistic in this regard, we shall simply not get the force posture we desire, or we shall be faced with the necessity for costly terminations after investing precious fiscal assets and technical manpower efforts which could better have been applied in another direction.

There has been a confused point of view in some quarters that the mere fact that, during the prosecution of one of our large projects, technology has marched forward, we would know how to do a much better job if we could start over. This leads to the remark that a weapons system is obsolete before it gets into service. It is not this kind of consideration which makes a weapons system obsolescent, but rather the threat posed against us by an enemy. So long as the weapons system will handle the threat against which it was designed, and so long as this threat still exists, the weapons systems is far from obsolete.

Some Notable Successes

Our first guided missiles systems to approach operational status were in the anti-aircraft fields—air-to-air and surface-to-air. Here we were concerned with times of flight of about thirty seconds. We have learned a great deal, and have had genuine success in achieving operational reliabilities which have made these systems effective.

The same can be said for several other types of weapons systems designed primarily for use in wars of limited objectives, as distinguished from our strategic weapons systems. I doubt whether it is generally recognized and understood that the possession by us of such weapons systems can, and does, exert a tremendous deterrent effect upon those who might be tempted to provoke situations which might lead to the so-called brush-fire or limited war situations. The feat of the Chinese Nationalists in shooting down four Communist planes with Sidewinders over the Formosan Strait last year must certinly have given certain people in high places reason to contemplate a bit.

Now the emphasis, at least in the public limelight, is with long range ballistic missiles. The guided portion of the flights is still only on the order of five minutes, or less. The performances in the Atlas program, which is now becoming operational, and in the Polaris program, which is to become operational by the end of this year, are gratifying to say the least. They show that we really understand the problems, and are on top of them. We can probably be quite confident of the later operability of Titan and Minuteman.

New Problems Arising

But we are now faced with new problems in our military space programs. After powered flights of just a few minutes, the sophisticated and precious payloads of these programs will be required to operate properly at least for months, rather then minutes, if they are ever to become technically and fiscally feasible, and operationally effective.

(Continued on Page 18)

a complete laboratory amplifier system with maximum flexibility and control

Designed around a power supply serving both as power source and mounting frame for six *plug-in* amplifiers, Gulton's new KF-1095 and KF-1096 Amplifier Systems save lab space, provide maximum flexibility of operation. Amplifiers (voltage or galvanometer) are designed as modular units, can be exchanged at will.

Present models feature high input impedance and low loading, particularly suitable for piezoelectric transducers. Amplifier modules for other applications, integration, carrier systems, etc. will be available soon.

Precision Gain Control: Employing a precise 10 turn potentiometer and calibrated dial, the gain can be set and locked or continuously varied. Accurate calibration and excellent linearity permits immediate resetting to any desired gain level without need for additional checks.

Sensitivity control indicates gain and millivolts per unit of measurement, i.e., in vibration measurements, mv/g. This arrangement provides a convenient means for measuring "g" levels and calibration of accelerometers.

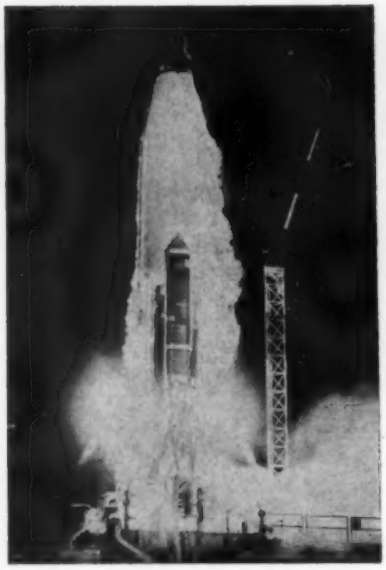
Maximum Reliability — Minimum Maintenance: All-transistorized current amplifier and hybrid circuit voltage amplifier provide maximum reliability with optimum performance. Reduced power consumption means less heat generation, lowest maintenance factor.

For complete details and specifications, write Instrumentation Division, Gulton Industries, Inc.

SPECIFICATIONS

	Voltage Amplifier	Galvanometer Amplifier
Gain:	variable 0.5 to 500	variable 0.05 to 3
Gain Accuracy:	better than 3% of reading	not calibrated
Gain Stability:	better than 1%	max. drift 2 mv/°F
Frequency Response:	±10% 10cps to 20KC	±5% 10cps to 10KC
Input Impedance:	75 megohms, min.	25,000 ohms
Noise:	less than 500 u v rms, rti	negligible
Output Voltage:	5 volts rms into 25 K load	±100 ma into 35 to 100 ohm load
Linearity:	better than 2%	better than 2%

Gi® INSTRUMENTATION DIVISION
Gulton Industries, Inc. Metuchen, New Jersey
In Canada: Titania Electric Corp. of Canada, Ltd., Gananoque, Ont



The majestic Atlas rising smoothly into the sky at Cape Canaveral (left) is a product of exacting combined environment operating tests performed at the San Diego labs of Convair-Astronautics (above) and at many sub-contractor laboratories.

by C. C. Campbell

Design Specialist
Convair-Astronautics

'Search for Critical Reliability'

With the ballistic missile came major efforts to simulate end-use environments in combination. Here is the story of how America's mighty ICBM, the Atlas, was put through its environmental test paces, and how failure trends that might have caused millions of dollars worth of losses were discovered in the lab and corrected.

THE ADVENT OF THE BALLISTIC MISSILE resulted in major efforts to satisfy the long-felt need for testing components under a combination of end-use environments. At Convair-Astronautics, prime assembly and test contractor for the Atlas missile, this took the form of a continuing test program known as the "Search for Critical Weakness."

The philosophy of the program is simply this: Missile system reliability can best be improved by testing components under simulated operational environments, with design improvement when weakness is detected.

It was evident from the outset that many problems would have to be solved before the full benefits of the program could be realized. Facilities with the required capabilities were limited. Environmental conditions were difficult to simulate for large and complex components. Operating conditions calling for use of liquid oxygen, helium and hydraulic fluids under high pressures and high flow rates had to be considered.

A Task for Many Labs

It was evident at the time, too, that no one laboratory would be able to handle the volume of testing that would be required. Thus far, for example, more than 300 missile-borne component types, consisting of more than 1,500 individual specimens, have been tested for reliability. These include electrical components, such as battery packages, inverters and transponders; mechanical, hydraulic, pneumatic and propulsion items, such as staging valves, reservoirs and accumulators, and electro-mechanical units, such as servo valves, separation devices, programmers and destruct systems.

The lack of facilities with the required capabilities limited requirements for the first phase of the "Search for Critical Weakness" to single environmental conditions. Combined environments were introduced as rapidly as the required facilities became available.

There have been many advances in equipment and techniques since that first testing phase got under way more than four years ago. Consider:

Vibration equipment with greatly increased force output has been developed, making it possible to test heavier components over wider frequency ranges.

Many laboratories have added facilities for high-flow, high pressure helium gas output, with recovery systems

to collect, clean and reuse this valuable gas.

Other laboratories have installed complete cryogenic flow facilities.

New chambers, capable of simulating extreme altitudes and combined environments, have been developed.

Combinations Past—and Future

Facilities combining altitude, temperature and vibration became available, on a limited basis, during the second phase of the program, and at present all components allocated to "Search" testing are undergoing some form of combined environmental testing. The next step will be to include sustained acceleration with vibration, temperature and altitude. The prospect for this is promising.

Whatever the phase, the basic testing philosophy remains unchanged. Components are subjected to simulated environmental conditions at three different levels, while being operated. The first test series is at design requirements, and the next two are conducted at reasonable levels of intensity beyond design requirements to establish a safety margin. Being beyond design requirements, the safety margin becomes a yardstick of reliability.

Figure 1 shows a failure incurred by a helium staging valve during the third level of vibration intensity. Examination disclosed that the valve had been weakened by undercutting in the area of a sharp thread root. The weakness was easily corrected, but it would not have been revealed had tests been conducted only at design level requirements.

Testing Many Specimens

Testing components operating under combined environments provides invaluable information on performance characteristics. Extensive test equipment must be utilized, however, to implement this technique. For example, in testing the booster and sustainer fuel supply disconnect valve, liquid fuel was provided at operational pressure while the specimen was being vibrated and while separation tests were being performed. In addition, the sustainer portion of the specimen continued to be vibrated after the booster portion had been separated to determine the combined effects of vibration and disconnect tests on the sustainer portion.

Tests are conducted on sample sizes ranging from five to twenty specimens, because testing more than one specimen of each component increases the confidence level in the test results and provides data performance variability.

There have been instances of failure of only one out of ten or twenty specimens. For example, in testing the helium rise-off disconnect valve, the poppet in the airborne portion stuck open on one out of ten units tested—a failure that would lead to loss of propellant tanks pressurization. In the Atlas, this is tantamount to losing the missile, as the propellant tanks would collapse.

Examination of the failed specimen disclosed that the spring bowed while under pressure, thereby creating a side load on the poppet causing it to remain in an open position (Fig. 2.) The chances of discovering such a weakness would have been small if only one sample had been tested.

Operating During Test

Combining environments and operating components under test are major factors behind the revelation of many component weaknesses not disclosed when the component is in a static configuration and environments are applied one at a time.

¶ There was leakage around the various types of seals during tests in which low temperature and vibration were combined, while no leakage occurred on similar components during tests in which low temperature and vibration were applied one at a time.

¶ Diaphragms and aluminum parts were determined to be susceptable to failure under combined high temperature-vibration conditions.

¶ Electronic equipment, in general, showed weaknesses with respect to broken leads, solder joints, vacuum tubes and wiring interference problems when tested under combined environments.

¶ Rotation equipment was susceptible to failure when subjected to sustained acceleration tests while being operated, it is possible that even more failures would have occurred had vibration and temperature been combined with acceleration.

Several coil springs failed during compression tests while being operated under simulated environmental conditions. It was found that the spring would bow when

C. C. Campbell has been in the reliability group of General Dynamics Corporation's Convair-Astronautics division for nearly seven years. His assignment: designing and implementing reliability test programs for the Atlas and other space projects. Before this he was with Sperry Gyroscope Co. for five years in tactical studies and reliability testing of the Sparrow I missile program. He also has served three and a half years in the Navy. Holder of bachelor and master degrees in math from Boston U., he also has done graduate work at NYU. He was vice president of the Institute of Environmental Engineers in 1957-58 and is active in the San Diego chapter of the Institute of Environmental Sciences. He made a report similar to "Search for Critical Reliability" at the 1960 meeting of the IES.

Campbell

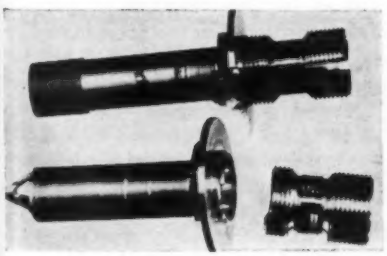


Figure 1
Staging coupling assembly: Sharp thread root and severe undercut led to fatigue failure.

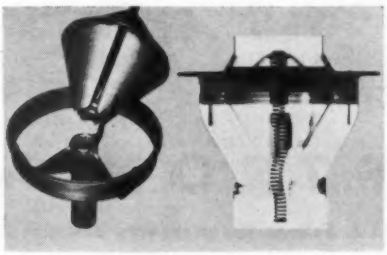


Figure 2
Helium rise-off disconnect: Galled surfaces and x-ray of bowed spring.

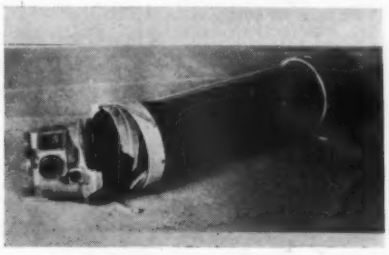


Figure 3
Sustainer hydraulic tank: Showing fracture at sharp corner.

compressed and rub against its housing, scraping the housing metal and causing a serious contamination problem. In addition, the bowed springs imposed a side load on the poppet causing the component to bend or perform erratically. Failure of any one of these springs during flight could have caused flight failure—a high price to pay for a faulty spring. Alerted to this trend, designers took steps to eliminate the weakness.

Another example involved the failure of a large percentage of components to retain structural integrity during vibration tests. In some cases these failures occurred around welded areas, and improved inspection techniques were introduced to eliminate this type of weakness.

A number of the failures were attributed to "stress raisers" in fatigue areas of specimens, caused by insufficient blend radii where geometrical discontinuities exist or where sharp corners act as focal points for stress concentration (Fig. 3).

Reliability and Design Review

Test results are reviewed by reliability and design personnel, who come up with an initial evaluation. Then a final statistical analysis is made, consisting of:

(1) An investigation of performance variability for each component as a function of environmental severities.

(2) A study of the performance variability between specimens of the same design.

(3) An evaluation of comparative reliability.

Following the final analysis, recommendations for improving the reliability of the component are submitted to the cognizant design department.

Convair maintains a selected source list of about twenty environmental testing laboratories. Subcontracts are issued on a competitive basis with approximately four laboratories bidding on each component type to be tested.

About six weeks' elapsed time is required for a typical test, from the time the specimens arrive in the laboratory until the final report is completed. Bi-monthly progress reports are also submitted, and there is immediate notification in the event of specimen failure. Final reports are written in accordance with MIL-T-9107.

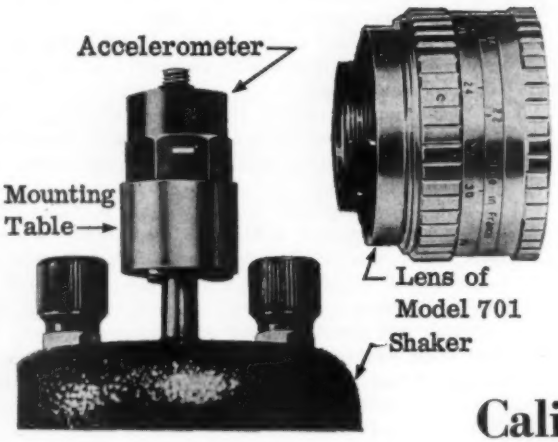
Exclusive Facilities

(Continued from Page 14)

This kind of performance may be an order of magnitude more difficult to achieve and will offer one of the greatest challenges imaginable to our technology.

I do not propose to know the answer. It seems quite clear that these vehicles will be so complex and so expensive that any thought of achieving reliability through large scale firing programs, with corrections being introduced from shot to shot, seems doomed before we start. In the first place, there is not sufficient time, in the second place, facilities probably will not permit it; and in the third place, such a program would be fantastically expensive.

It seems quite possible that, having engineered a design to the best of our ability, we shall need new environmental test facilities which are used exclusively for long-term tests, so that no competing project can be breathing down the neck of the facility manager while awaiting its turn. I believe we simply must have a greater assurance of something approaching complete reliability over a long time period before we can hope to see presently planned programs come to fruition.



OPTRON Model 701 DISPLACEMENT FOLLOWER

Measures Vibration

To measure the displacement of an accelerometer, simply focus the spot of light from the Optron Model 701 on the edge of the accelerometer. It's that easy! **Frequency response**: Static to 7 kc. **Resolution** 12 micro inches.

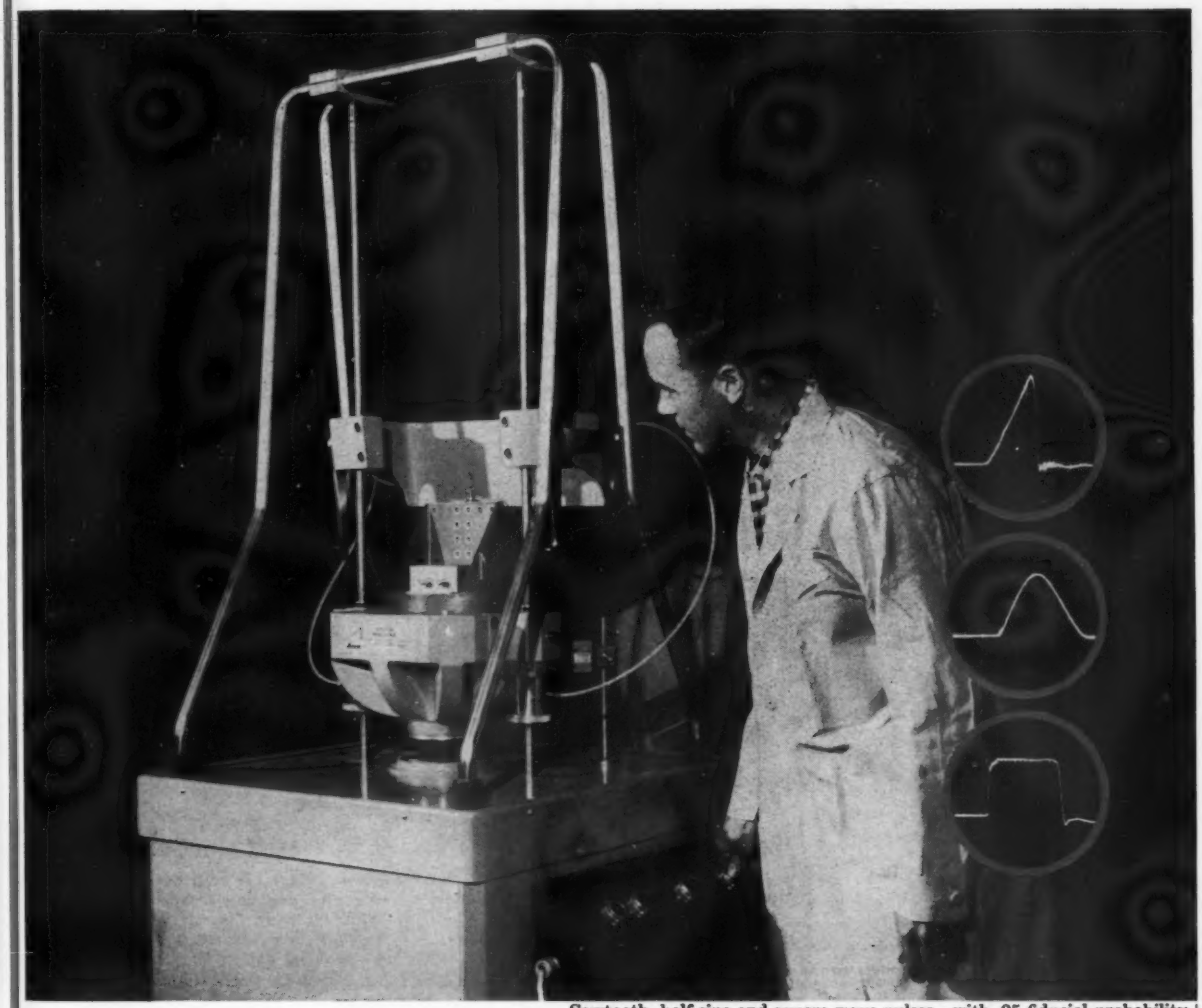
Calibrates Accelerometers

Optron Model 701's interchangeable lenses provide five ranges: .050", .100", ½", 1" and 2" full scale. A heavy seismic stand provides isolation from the floor from 2 cps up. Model 701 never requires jigs or fixtures clamped to the work—it never makes contact with the specimen. It works on any material regardless of size, shape or composition—and it works in daylight!

OPTRON Corporation

335 S. Salinas Street • Santa Barbara, Calif.

Phone: WOodland 5-6140



Sawtooth, half-sine and square-wave pulses—with .95 fiducial probability.

Avco Shock Test Machine offers . . .

widest variety of pulse shapes available

for faster environmental tests with unmatched repeatability

Avco's precision Shock Test Machine SM-010 is a mechanically simple device that reproduces shocks such as those encountered in missile flight. And it produces these shock pulses faster than with conventional machines.

The SM-010 is extremely accurate. It will produce an unusually large number of different shock pulses with a 2.5% repeatability and a .95 fiducial probability. A complete testing cycle, handling specimen loads up to 100 lbs. requires only 7 seconds. No readjustment is required. In addition, normal shocks usually met in handling and shipping are easily reproduced.

Easy to install, simple and safe to operate, Avco's SM-010 offers these other advantages:

- **Provides sawtooth, quarter-sine, half-sine, square and triangular pulses as required**
- **Exclusive design rebound brake as standard feature**
- **Exclusive specimen carriage permits greater variety of tests, ideal sawtooth pulses**
- **Meets rigid specs of Ballistic Missile Environmental Test Requirements**
- **Shock pulses up to 3000 g's for transistor testing**
- **Can be operated by unskilled, non-technical personnel after brief instruction**
- **Needs no special foundation or installation; base only 2 feet square**
- **Accessory package available**

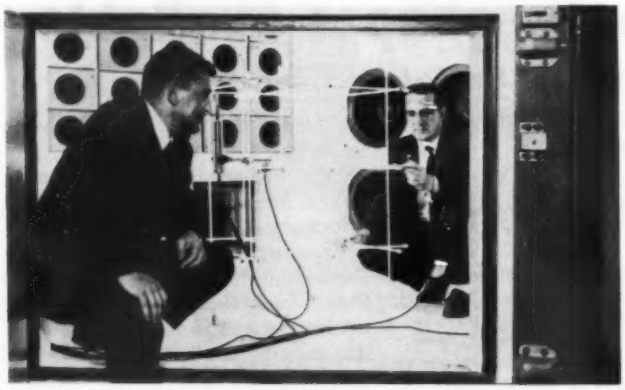
Other shock test machines with capacities from 25 to 500 lbs., producing essentially identical shock pulses, are also available. For more information, contact your nearest representative—offices located throughout the continental United States and the world. Or, if you prefer, write: *Industrial Products Subdivision, Research and Advanced Development Division, Avco Corporation, Wilmington, Mass.*

Avco

Research & Advanced Development

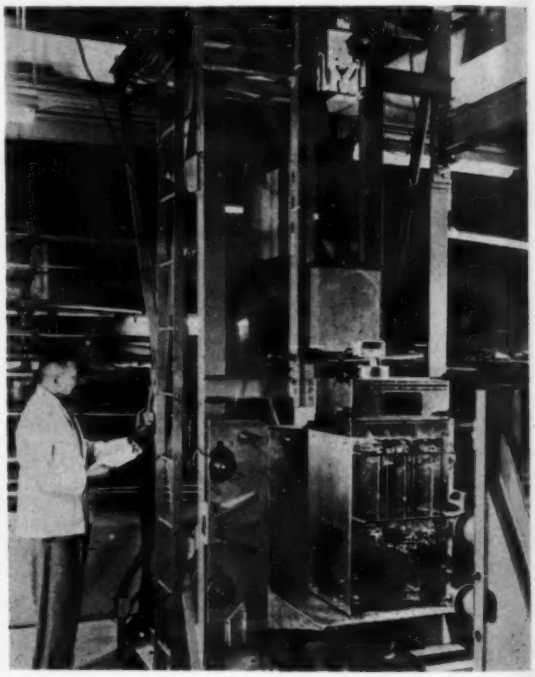
Environmental Quarterly's Album of People,

MEETING OF THE MINDS: Lee Permut (standing in photo above), a principal officer of Aerotest Laboratories, Inc., Deer Park, N. Y., welcomes Dr. Melvin Zaid, of Technik, Inc., Garden City, N. Y., to a conference, while H. J. Shapiro, of Aerotest, looks on. Aerotest, specialist in environmental and other kinds of testing, has a working affiliation with Technik for advanced research and development projects.



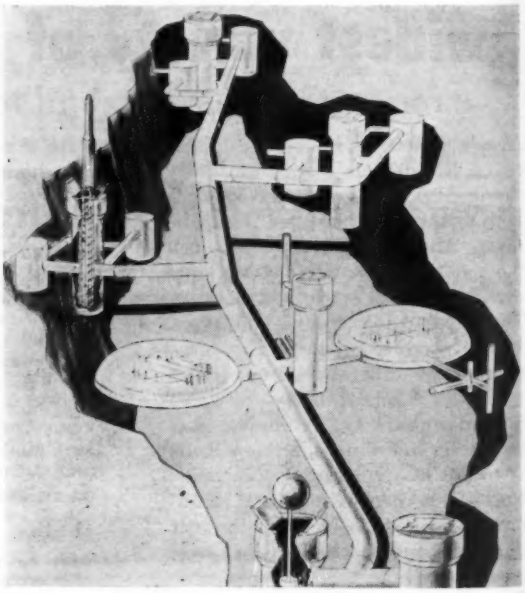
SOUND ABROAD: At Avco Corp.'s Research and Advanced Development Division, Wilmington, Mass., a 146-db acoustic noise facility (above) is demonstrated to Jean Agliany (left), of France's Sud Aviation, by Al Pelletier, project engineer, in an acceptance test. The manufacturer claims the 200 cf facility is capable of producing a higher sound pressure level than ever before achieved in a large capacity reverberant chamber. A total of 36 noise generators and 21 power amplifiers are used. The chamber is pentagonal shaped for uniform sound pressure levels. (For more information circle EQ RSC "I".)

42-TON SPACE SHIP: A 13' x 26' ionosphere chamber, built by Tenney Engineering, Inc., is shown (left) as it arrived at Republic Aviation Corp., Farmingdale, N. Y. The $500,000 chamber, here being jockeyed into position, will test men and equipment at altitudes of up to 150 miles. (For more information circle EQ RSC "J.")

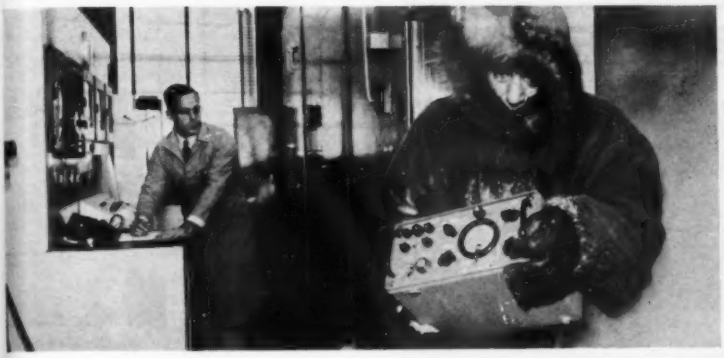


COFFEE, ANYONE? Even coffee urns must pass severe environmental tests to qualify for nuclear submarine duty, so Herb Frisby (above), technician at Barry Controls, Watertown, Mass., flailed away with a 400-lb. drop hammer. The urn brewed on. (For more information circle EQ RSC "K".)

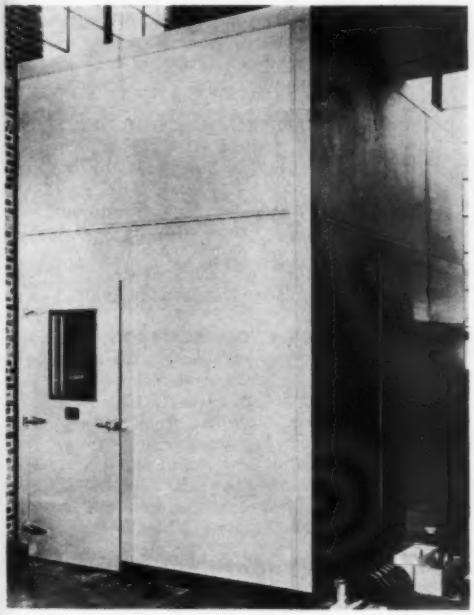
TITANIC NEST: A typical Titan ICBM complex, silos, portals and all are illustrated (below) by an artist. The Rucker Company, Oakland, Calf., manufacturer of hydraulic and missile GSE and fluid power systems, is installing same at Ellsworth AFB.

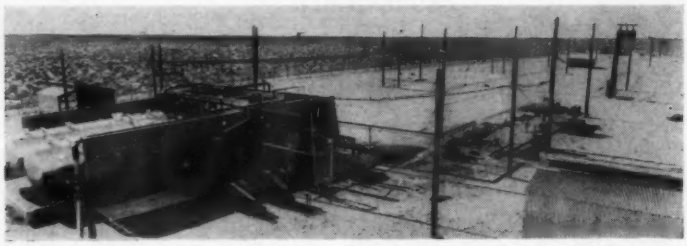


Products, Places and Ideas...



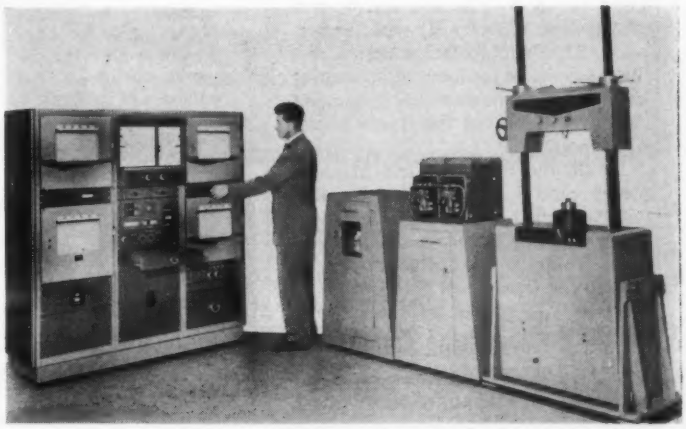
MAN FROM OUTER COLD, in the person of William H. Siebrecht, emerges (above) from Conrad-built altitude-temperature-humidity chamber of United Aircraft Corp.'s Norden division in Stamford, Conn. For vibration tests of —100° to +500° F., up to 100 per cent humidity and altitude to 150,000 feet, a 5,000-force pound vibration table is moved in. The 25-ton enclosure rests on a rubber pad to guard against extraneous vibration. At right, Siebrecht, who is in charge of Norden's environmental test equipment, adjusts a Stokes pumping unit.



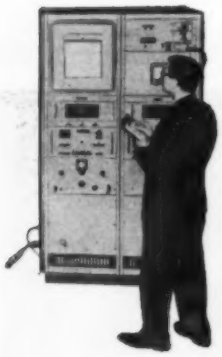


COLDER STILL, IN CALIFORNIA: Garrett Corp.'s AiResearch Manufacturing Co. disclosed recently that it has been operating a cryogenic test facility in the remote, sparsely settled Boron, Calif., area for 2½ years. It provides full-scale component testing with liquid hydrogen. The view (above) shows test area with shelters rolled back at the left of the picture, and a control room 400 feet to the right.

SILENCE, PLEASE: To isolate the noise generated by shake table operations, Industrial Acoustics Company, Inc., of New York, has resigned this "Quiet-Room" (left). The structure is made acoustically rated acoustic panels in many sizes. (For more information circle EQ RSC "L".)



ALL-EMBRACING TEST: Research, Inc.'s versatile new materials test system (right) is capable of simultaneously programming and applying rapid variations of temperature and load while separately recording temperature, load and strain with respect to time, as well as load vs. strain directly. Lockheed's Missile Systems division is the first to use this new equipment, which consists, from left to right, of a control console, hydraulic pump, resistance heating transformer and adjustable tension-compressor loading frame. (For more information circle EQ RSC "M".)



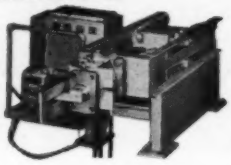
THE NEW

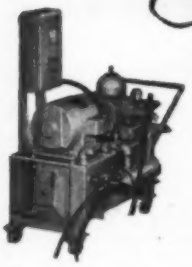
DYNATEST*

LOADS 50,000 LBS. AT 20 CPS

WHILE FOLLOWING A

TYPICAL





PROGRAMMED

HEATING

RATE

OF 200° F./SEC. TO 3000° F.

Add to that: hydraulic cylinder velocity of 1"/sec.; force-loading accuracies of ±0.5% (holding), ±1% (cycling); temperature-holding accuracy of ±15°F. And you have a system obviously well equipped for advanced materials testing. The temperature channel is available with radiant, resistive or inductive heating (or any combination). Manual and programming control are provided for each channel. Load, strain or deflection can be programmed simultaneously with temperature. The holding frame design permits removal of the load cell for testing large structures or unwieldy specimens. And everything but the frame is carriage mounted.

In all, the new Dynatest Machine merits careful consideration by anyone concerned with material behavior under extreme environmental conditions. You can make a good start by writing for Data Sheet S-101.

*Trademark

cdc

CompuDyne Corporation

400 South Warminster Road

HATBORO, PENNSYLVANIA

BA 2285

People You Know...

CHANGING ENVIRONMENTS

Granata

Giles

Pureco Promotes 3 Aides, Giles Managing Marketing

D. C. Giles has been appointed to the new post of manager-marketing of the Pure Carbonic Company, New York, a major manufacturer-distributor of carbon dioxide in gas, liquid and solid forms. Formerly assistant to the sales vice president, he is now responsible for marketing policies and the overall sales program.

A. J. Granata has become vice president-product application and development, and will be in charge of product research. He has headed Pureco's technical sales since 1951.

M. C. Kramer has taken over Granata's former post as manager-technical sales.

McKelvey

Kramer

V. L. McKELVEY, LEONARD E. LEOPOLD and **PAUL SAINT-AMOUR** are new field engineers with ENDEVCO CORPORATION, Pasadena, Calif., electronic instrumentation firm. McKelvey, formerly assistant sales manager for M. Swift & Sons, Hartford, Conn., is based at the Pasadena office. He is a Penn State alumnus. Leopold, who was district sales manager for International Research and Development Corp., will work in the Boston area. He is a graduate of Ohio State. Saint-Amour will be in the Cleveland area, where he formerly was field sales manager for Keithley Instruments.

Saint-Amour

Leopold

Gross

Garber

Garber, Gross New VP's At Consolidated Vacuum

Max Garber and Malvern J. Gross have been promoted to the new posts of marketing vice president and manufacturing vice president, respectively, at Consolidated Vacuum Corporation, Rochester, N. Y.

Garber has been director of marketing for CVC for the past 15 months and held various executive positions since joining the company in 1947. Gross came to CVC last October as director of manufacturing from Tracerlab, Inc., where he was manufacturing vice president.

* * *

EMMANUEL P. COURTILLOT has been named director of European planning, a new post, by VARIAN ASSOCIATES, Palo Alto, Calif. One of Europe's most prominent electronics executives, he resigned as manager of the Electronic Tube division of Compagnie Francaise Thomson Houston to join Varian.

* * *

JAMES E. CULBERTSON, who formerly was responsible for the reliability coordination department at WESTERN ELECTRIC COMPANY's North Carolina works in Winston-Salem, has become department chief of the environmental laboratory. He succeeds H. R. JOHNSTON, who has moved to the Bell lab in Whippany, N. J.

* * *

F. W. THOMPSON is the new assistant program manager for the Autonetics division of NORTH AMERICAN AVIATION.

* * *

CARL MUNCY has been named head of the Controlled Environments branch of the Naval Ammunition Depot, Crane, Ind.

* * *

RICHARD V. CARROLL has been promoted to senior applications engineer in charge of R-F instrumentation at BORG-WARNER CONTROLS, Santa Ana, Calif.

* * *

HARRY N. COTTLE has been named chief engineer of the engineering department of MB ELECTRONICS. An MIT alumnus, he came to MB in 1949 from Curtiss-Wright.

Pesci Leaves PDC—Janecka Named Editor of Newsletter

Frank B. Pesci has resigned as editor of the "Newsletter" of the National Academy of Sciences-National Research Council's Prevention of Deterioration Center to become assistant to the dean of Prince George's Community College, Suitland, Md.

His successor as editor is Hans-Peter Janecka, a PDC staff member who has studied at Berlin, Wurzburg, Innsbruck and Georgetown Universities.

* * *

DAVID E. HEMINGWAY has joined RICHARD D. BREW & COMPANY, Concord, N. H., in the new post of general manager of the environmental engineering laboratories. He was previously an Air Force electronics maintenance officer.

* * *

WAYNE D. PATTERSON has been appointed sales engineer in the Los Angeles office of THE RUCKER COMPANY, Oakland, Calif. Patterson has nearly a decade of experience in installation, servicing and sales engineering of hydraulic, pneumatic and electrical controls and power systems.

* * *

ROBERT "JERRY" ALGER and **GEORGE McCLARITY** have been assigned sales posts at TECHNOLOGY INSTRUMENT CORP., Acton, Mass. Alger will be a sales engineer in the New England territory and McClarity will be New England factory salesman. Alger has been involved in metal film development work for a number of years at TIC and at TIC's ACTON LABORATORIES, INC. McClarity was formerly a TIC sales engineer.

Bernbach

Patterson

* * *

HERBERT A. FINKE has been named to the new position of director of long range product planning at VARIAN ASSOCIATES, Palo Alto, Calif. He comes to Varian from Polytechnic Research and Development Corp., where he was vice president and general manager.

* * *

LELAND F. BERNBACH has joined HORKEY-MOORE ASSOCIATES, Torrence, Calif., as manager of the testing division. Associated with Norair division of Northrup for the past 18 years, he was general supervisor of the materials research lab there.

From Varian, a completely stable high-vacuum pump, effective even when handling atmospheres with high concentrations of noble gases such as Argon.

now—Super VacIon with argon-stable cathode!

Another significant advance from Varian's research program, solving the problem of pressure surges when requirements specify the evacuation of atmospheres containing Argon or other noble gases. Identical in all respects with Standard VacIon pumps, save for inexpensive modifications to the diode pumping element.

Super VacIon is now available in pumping speeds from 1 litre/second to 10,000 litres/second. All replacement pumping elements, either standard or Argon-stable, are interchangeable; your present VacIon pump can be modified in the field. No need for complex triode or tetrode pumps, no need for additional power supplies. Super VacIon operates from the same single power source as does the standard VacIon pump.

For complete technical data on how Super VacIon can solve your special pumping problem, address Vacuum Products Division.

The VacIon pump, developed by Varian Associates, is a revolutionary concept in vacuum pumping. VacIon employs no moving parts, no fluids, no refrigerants. VacIon's electronic construction will provide clean vacuums to one-trillionth of an atmosphere.

VARIAN associates

PALO ALTO 50, CALIFORNIA

Representatives throughout the world

KLYSTRONS, WAVE TUBES, GAS SWITCHING TUBES, MAGNETRONS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, NMR AND EPR SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES.

by Spencer A. Tucker
Partner
Martin & Tucker, Engineers

Reliability Testing for Managerie

Easy-to-use 'break-even' charts help management predict the economic impact of adding equipment and personnel . . . of cutting prices or increasing costs . . . and of changing service or product mix. They can guide marginal pricing policies and generally point up the quality of decisions that result in success of failure in the competitive environment.

REGARDLESS OF THE SIZE of a company or installation, a time comes when major economic decisions must be made. The quality of these decisions fixes the ease of profit making, the ability to compete and chances of survival.

Break-even (B-E) charts provide an opportunity to test the effects of managerial decisions in advance. They are, in effect, a kind of environmental chamber for management.

To construct a B-E chart, expenses must be divided into variable costs that change with volume, such as materials and direct labor, and fixed costs, such as depreciation and rent. Some expenses, such as supervision, have portions of both.

Break-Even Illustrated

Exhibit 1 illustrates the conventional and B-E methods of stating expenses to find out the profit trend. Note that the conventional method considers cost as a total unit of one million dollars, while the B-E breakdown results in two parts. These are used in setting up the chart in Figure 1.

The diagonal (Fig. 1) is the sales line. The horizontal base line is the sales capacity and the left vertical line is for expenses. Both are scaled in dollars. The broken line paralleling sales represents the fixed expense level. It remains the same for all sales.

The total expense line is drawn from the minimum of $320,000 at zero sales to a maximum of one million dollars at maximum sales. The point at which the total expense line crosses the sales line is the break-even point. In Figure 1 this is $740,000—the point at which there is neither profit nor loss. When volume rises above $740,000, profits are made; below it there are losses.

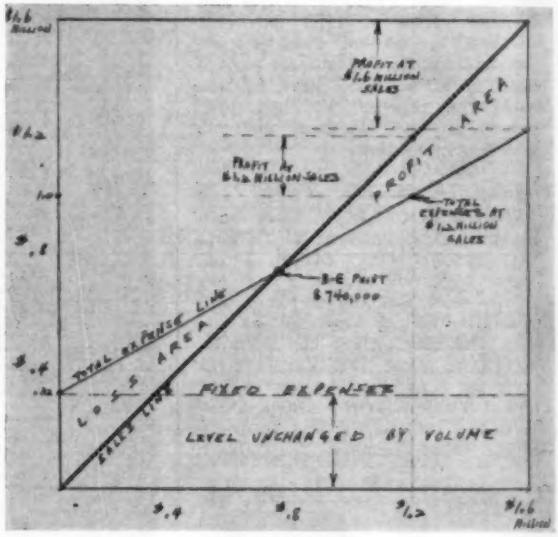


Figure 1

In other words, when the B-E point rises, the company has to sell more to maintain its level of profit. Sometimes the rise makes the company vulnerable to price reductions.

Segregation of Fixed and Variable Expenses at $1,200,000 Sales Level

Expenses	Total Costs	Kind of Cost	Fixed Amount	Variable Amount
Direct materials	$350,000	Variable	—	$350,000
Productive labor	200,000	Variable	—	200,000
Mfg. overhead	250,000	Both	$200,000	50,000
Administrative exp.	100,000	Both	75,000	25,000
Selling expenses	100,000	Both	45,000	55,000
TOTAL EXPENSES	**$1,000,000**		**$320,000**	**$680,000**

Exhibit 1

ecisions

In 23 years as an industrial engineer and management consultant, Spence Tucker has served more than 200 companies in the electronic component, metalworking, assembly, machine shop and packaging industries. Now a partner in the consulting firm of Martin & Tucker, Little Neck, N. Y., he is licensed in 11 states and two Canadian provinces, where he has offices in Montreal and Toronto. He is in great demand as a lecturer and has written dozens of articles and two new books, "Successful Managerial Control by Ratio-Analysis" (McGraw-Hill) and "Finding Products Costs with Machine-Hour Rates" (Prentice-Hall). Memberships include ASME, AIEE, AIIE and IRE.

Tucker

At other times a change in the B-E point may impose psychological pressures leading to desperation pricing or uneconomic utilization of facilities.

Adding equipment or personnel, or shifting the product

Good or Bad? It Depends

or service mix can raise the B-E point. This can be good or bad, depending on the the state of the company and how the move affects fixed and variable expenses.

A decision to add equipment will raise the fixed expense item and result in large profits in boom times. But in periods of recession, the company will be in a tight spot, since it cannot readily adjust expenses to lower income.

The same concept applies to utilization of an item of test equipment. Acquiring a multi-function chamber to expose a product requiring a single environment is tantamount to lowering the lab's economic elasticity. In short, it is adding the investment burden of an unused piece of equipment.

If the B-E point rises because a variable expense is increased, the company will not make as much profit during boom times, but it will be on safer ground during a recession since its expense pattern is much easier to change. In boom times, fixed expenses are, of course, capitalized more handsomely.

Assessment of Future Is Important

Expansion based on today's volume and market is like building a house without a roof on the assumption that because the sun is shining today, it will never rain.

Figure 2 shows the before and after B-E points of a testing company thinking of expanding capacity 40 per cent by adding equipment. Its fixed costs currently are $800,000, and its variable costs are $931,500, or 45 per cent of sales. Its present maximum sales level is $2,070,000 and its B-E point is $1,450,000—as shown by the intersecting lines on the chart.

The extra 40 per cent capacity would raise fixed expenses to $1,000,000, a 25 per cent increase. Variable costs would remain 45 per cent of sales, which are now planned at $2,900,000. The new B-E point would be $1,820,000, up $370,000.

Profit at full capacity before expansion was $350,000. With the additional equipment, sales would have to rise to $2,460,000 to produce the same profit. Thus, acquisition of the new equipment means a sales increase of at least $390,000 to end up with the same profit figure, and is not warranted unless there is considerable justification for the expectation of even greater sales.

Applies to Non-Profit Set-up, Too

It doesn't matter whether the activity is profit-making or non-profit in nature. As long as the latter must operate within a budget it faces the same evaluation, with equal force.

What happens if the expected sales increase does not materialize? Suppose (Fig. 2) that sales stay at the same

	Before	After
Fixed Expenses	$ 800,000	$1,200,000
Variable Exp.	1,800,000	1,200,000
TOTAL EXPENSES	$2,600,000	$2,400,000

Exhibit 2

$2,070,000 level? Then profits would be only $138,500—a 61 per cent drop in profits caused by a 16 per cent drop in sales. This is an example of loss vulnerability. Obviously, if sales dipped slightly more, a loss would be created.

Like so many companies that boost the level of their fixed expenses by retaining permanent departments, doing more "make" than "buy," indulging in unjustified "front" expenses and failing to police creeping losses, this company acquired a rigid fixed-expense pattern that can be removed only by major surgery. Of course, increases in "cash-outlay" types of fixed expenses are adjusted more easily.

Some expansions are made without a change in the B-E point. Exhibit 2 gives data on one company's "before" and "after." While fixed expenses rose 50 per cent as a result of the increase, this was offset by a one-third reduction in variable expenses.

As long as the company believes that its normal sales volume will not fall below the B-E point (Fig. 3), which

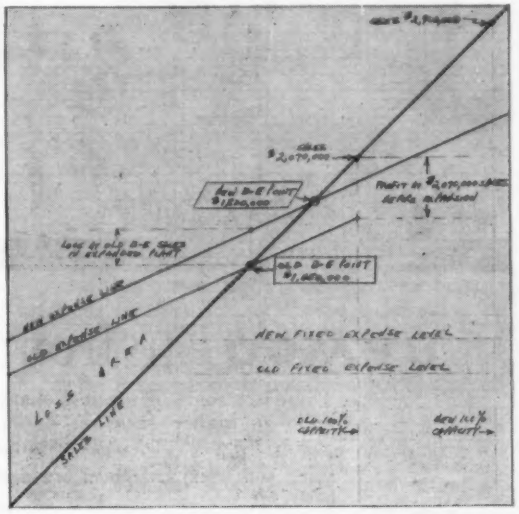


Figure 2

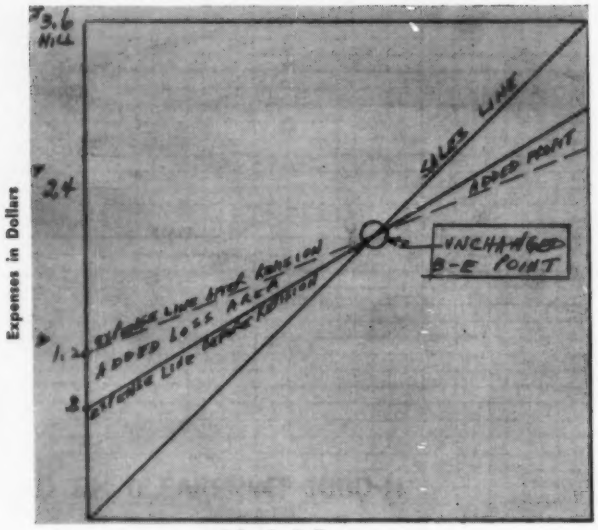


Figure 3

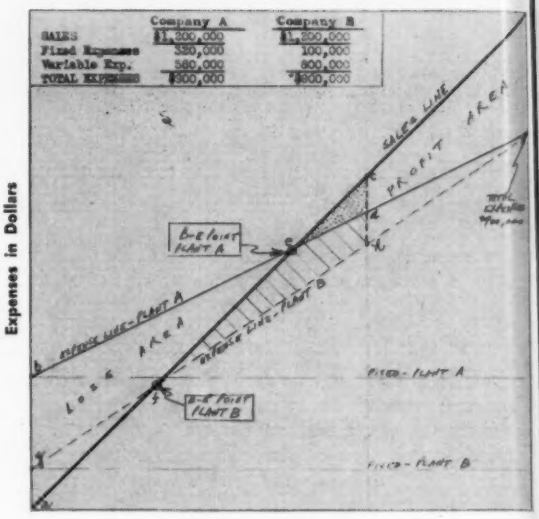


Figure 4

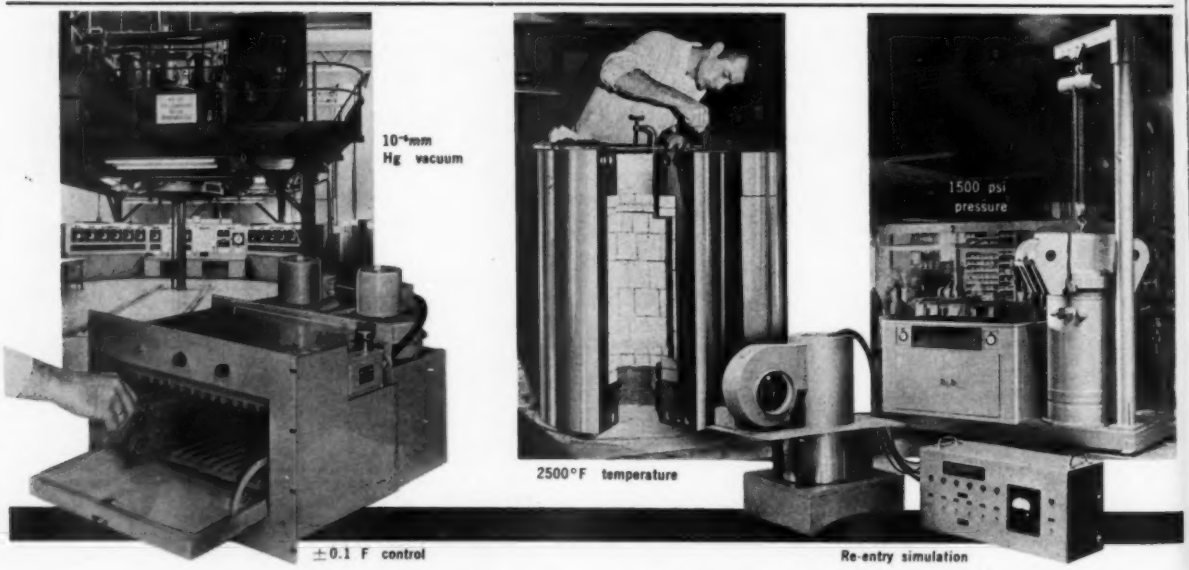
remains unchanged, all volume over this point will produce a greater profit than formerly enjoyed.

Coping With Competition

A B-E chart can also illustrate graphically the ability to cope with competition. The data in Figure 4 show two companies in the same industry making the same profit at maximum capacity. Because of their different internal economies (economic personalities, if you will), their earnings differ considerably below this peak level.

Company A bought additional equipment as a panacea for higher profits, had excessive administrative expenses and experienced low productivity. Company B used older equipment but squeezed every last cent out of it, farmed out some production work and kept tight control of methods and costs.

Company B's B-E point was $300,000, Company A's, $618,000. When sales volume was at $300,000, Company B



BEMCO Environmental Test Equipment

These are some of the test chambers built by Bemco to specific requirements. We build to higher or lower performance as well, incorporating highly specialized engineering talents, and advanced knowledge of the state of the art.

Many Mil. Spec. chambers are available for immediate delivery — on a sale or rental basis.
Write for the complete Bemco catalog.

BEMCO INC. 11631 VANOWEN STREET, NORTH HOLLYWOOD, CALIF. E.E.I. MEMBER

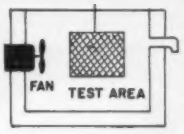
here's 4 ways

CARDOX® CO_2

can help you achieve
versatile... fast... low cost

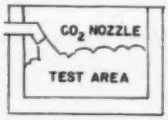
BELOW 0° F. ENVIRONMENTAL TESTING

1 dry ice chamber



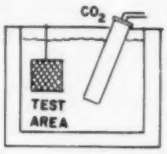
Simple, easy, inexpensive. A fan blowing over a wire basket full of crushed dry ice will reduce chamber temperatures from 0 to —70°F. A quick, low cost method for making occasional or isolated cold tests.

2 direct discharge of liquid CO_2



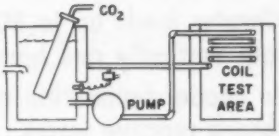
Easiest, most efficient method for consistent, cold testing in production operations. Bulk liquid carbon dioxide is discharged directly into the test chamber. You get controlled test conditions from 0 to —100°F. in 60 seconds or less. Best of all, one CO_2 storage tank can serve a battery of test chambers.

3 immersion tank method



For low cost production-line cold testing. Crushed dry ice or bulk liquid CO_2 is injected into an acetone, methanol or trichlorethylene base solution. Items to be tested are immersed in the slurry which has a temperature of minus 109°F. An ideal method of making cold "shock" tests.

4 indirect cooling method

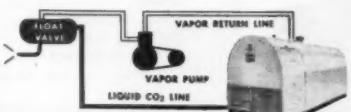


Bulk liquid CO_2 is discharged directly into refrigerant line or surge tank containing acetone, methanol or trichlorethylene type solution. Refrigerant is then pumped thru test chamber to reduce temperature by means of coil-type heat exchanger. Major advantage—no CO_2 atmosphere in test chamber . . . an important factor where this condition is not desirable.

This exclusive feature can save you up to 15%
CARDOX® PATENTED RE-CYCLING SYSTEM keeps Liquid CO_2 COLDER . . . minimizes vapor loss

Low pressure liquid Carbon Dioxide storage tanks are located some distance from the point of use. Heat in the piping may vaporize a part of the liquid CO_2 so that vapor as well as liquid CO_2 arrives at the nozzle. This is undesirable for several reasons.

1. The vapor has reduced refrigerating effect and results in a loss of CO_2.
2. The vapor causes intermittent discharge; discharge rate and control is affected.
3. Starting may be delayed as large amounts of vapor must be discharged before pipe cools sufficiently to eliminate creation of vapor.
4. Vapor discharge can interfere with temperature control accuracy.



The exclusive Cardox Re-Cycling System eliminates these disadvantages.

Float valve just prior to the nozzle separates vapor from the liquid CO_2. A vapor pump connected to a return line pumps the vapor back to the storage tanks.

The new Cardox Re-Cycling System means greater efficiency, control and economy for users of bulk liquid CO_2 systems.

GET THE FACTS ON CO_2 TESTING

To receive your copy of a new illustrated booklet fully describing the various methods of CO_2 testing in use today, mail this coupon attached to your letterhead to:

CARDOX
DIVISION OF CHEMETRON CORPORATION
Dept. 1027-R, 840 N. Michigan Ave., Chicago 11, Illinois

CHEMETRON

CARDOX® PRODUCTS: Carbon Dioxide Fire Extinguishing Systems, Trucks and Foam Fire Equipment . . . Liquid Carbon Dioxide . . . Carbonic Gas . . . Dry Ice

This Seal of Approval

ENVIRONMENTAL EQUIPMENT INSTITUTE EEI

Guarantees QUALITY and SATISFACTION

ISSUED ONLY BY MEMBERS OF EEI

Write today for brochure giving complete details and membership.

ENVIRONMENTAL EQUIPMENT INSTITUTE
PRINCETON, NEW JERSEY

300 LB. L.A.B. Reaction Vibration Machine

- Vibrates loads up to 300 lbs., both vertically and horizontally.
- No special foundation needed to absorb reactive forces.

Frequency ranges up to 100 c.p.s.; acceleration to 20G. Changes of direction of vibration and displacement can be made in minutes with load in position. Write for complete specifications.

L.A.B. MANUFACTURES: Reaction-vibration machines for loads up to 10,000 lbs; Hydraulic sinusoidal vibration systems; Transportation simulators for impact, vibration, drop and compression testing.

L.A.B. Corporation Skaneateles 6, N.Y.

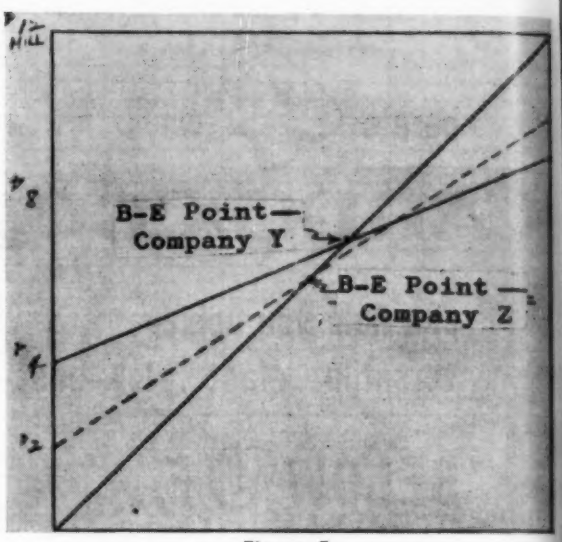


Figure 5

was neither gaining nor losing, but Company A was losing $320,000 in profits.

To survive in a recession, Company A would have to sell off equipment, eliminate administrative activities and improve operations—all almost immediately. Company B would not have to concern itself with such impractical moves. The larger portion of its expenses is variable and easily adjusted to volume dips.

In boom times, of course, Company A's profits would surge. It is a question of how good a prophet you are.

Vulnerability Varies

Look at the differences in vulnerability; the balancing between risk and gain. At $800,000 in sales, Company A's gain wedge is shown in the dotted area of the chart labelled d-e-c-, obtained at a risk of a-e-b. Company B has a more sensible operation: It gains the zone h-f-c by risking wedge a-f-g. Obviously Company A gains over the $1,200,000 sales level only.

A proportioning between the fixed and variable cost elements is necessary in planning for the longer term. A lower total expense does not necessarily protect a company from pitfalls. Exhibit 3 and Figure 5 show how a company with a *higher* total expense can have a *lower B-E* point. This is only possible because of the impact of fixed costs.

Both companies are in the same industry and make a similar line of products. However, Company Y has fewer hand operations than Company Z. While Z uses and pays more labor per unit, it keeps itself more elastic since it doesn't have Y's large investment in equipment. Z uses production wage incentives instead for boosting its output.

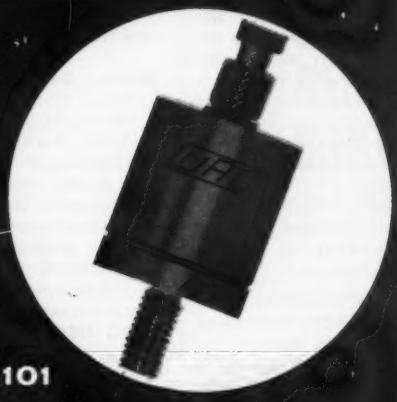
	Company Y	Company Z
SALES	$12,000,000	$12,000,000
Fixed Expenses	4,000,000	2,000,000
Variable Exp.	5,000,000	8,000,000
TOTAL EXPENSES	$ 9,000,000	$10,000,000
Net Profit before taxes	$ 3,000,000	$ 2,000,000
Vulnerability		
Profit at $7.2 million	$200,000	$400,000
Profit at $4.8 million=LOSS:	($1,200,000)	($400,000)

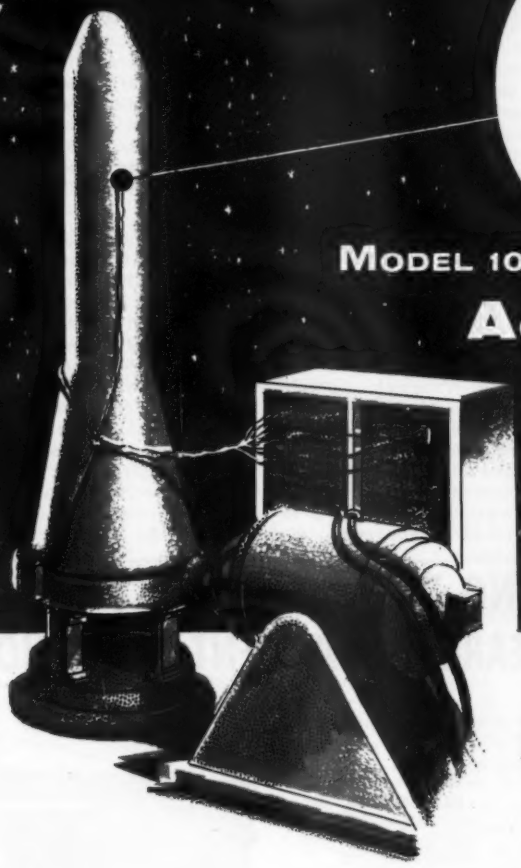
Exhibit 3

Expansions, price reductions, changes in staffing and other business moves are all fine if they can be justified economically. The company that plunges into one of these steps without first testing its effects is taking an exercise in chance. Properly classified data and break-even charts give management an idea of its company's characteristics. Then a safe and profitable growth path can be planned.

UAC RELIABILITY

In Electronic Instrumentation!





MODEL 101

Accelerometer

- *High Reliability*
- *Cross Sensitivity Down to 1½%*
- *Sensitivity to 40 mv/g*
- *Hermetically Sealed*
- *Insulated Mounting*
- *Ruggedized Design*

The UAC Model 101 self generating accelerometer has been engineered to overcome the limitations of presently available units.

For UAC Cathode Follower Specifications, send for Bulletin 301.

For High and Low Temperature Accelerometer Specifications, send for Bulletin 103.

ECTRONIC INSTRUMENTATION FOR AIRCRAFT, JET ENGINES, MISSILES, UCLEAR PROPULSION

UNITED AEROTRONICS CORP.

A subsidiary of United Aero Products Corp.

ELECTRONIC INSTRUMENTATION

BURLINGTON, N. J.

LITERATURE FOR ENVIRONMENT...

New EEI Brochure Details Member Firms' Capabilities

The Enviromental Equipment Institute, trade association of manufacturers of environmental equipment, has published an attractive 26-page brochure tracing the history of the industry and detailing the capabilities of its members and advantages of doing business with them.

In addition to telling what the EEI has accomplished in the seven years of its existence, the brochure introduces each of its member firms and reviews requirements for membership.

The Institute's Seal of Approval program is also discussed. *(For more information circle EQ RSC "A.")*

* * *

Aerotest Laboratories, Inc., Deer Park, N.Y., offers a 26-page illustrated brochure describing its unique advance propulsion and environmental test and research facilities. Functional and environmental testing of components and systems ranging from subminiature electronics to gas turbine engines are discussed. **(Circle EQ RSC #38).**

* * *

Conrad, Inc., Holland, Mich., describes its four standardized production models of test chambers in a new spec sheet. The chambers are 72", 48", and 36" in diameter by 60" deep, and 24" diameter by 30" deep, and are equipped with mechanical and diffusion pumping systems. Pumping down to one-half micron ranges from 3½ to 8 minutes. The chambers feature such accessories as rotary shafts, interior lighting, view ports and optional stainless steel liners. **(Circle EQ RSC #39).**

* * *

Barry Controls, Inc., Watertown, Mass., has a 6-page folder with an eye-catching aluminum and blue cover discussing its revolutionary "Rigidamp" method of drastically reducing resonant vibrations of all structures. Illustrated with sketches, pictures and a frequency graph, it gives a step-by-step explanation of how the "jelly-sandwich" laminations and inserts work, and discusses environmental applications. **(Circle EQ RSC #40).** Barry also has 2-page illustrated data sheets on its Series SM spring mounts **(Circle EQ RSC #41),** on its Series 4000 cup-mounts **(Circle EQ RSC #42)** and on its miniature L21 and L22 "lo" isolators **(Circle EQ RSC #43).**

* * *

Avco Corporation, Wilmington, Mass., has a 6-page, two-color bulletin on the Model SM-010-3 shock test machine which provides a wide variety of pulse shapes in testing cycles as short as 7 seconds. Environmental applications with specimens up to 100 lbs., as well as the machine's characteristics and operation are described. **(Circle EQ RSC #44).** Avco also describes its smaller SM-005 with 30 lb. capacity, which produces shock up to 3000 G, in an illustrated flyer. **(Circle EQ RSC #45).**

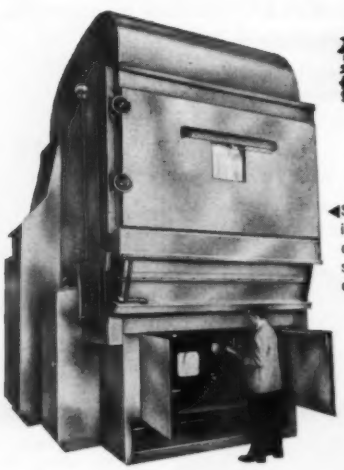
* * *

Consolidated Vacuum Corporation, Rochester, N. Y., has an informative, 32-page brochure on its extremely broad line of high vacuum gauges. Construction, operating principles, ranges and other features are discussed with appropriate illustrations. The line includes absolute manometers, thermal gauges, ionization gauges, combination thermal-ionization gauges, magamp controllers and sensing tubes. **(Circle EQ RSC #46).**

* * *

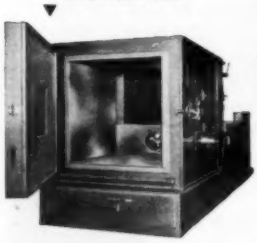
Unholtz-Dickie Corporation, Hamden, Conn., has issued a new short form catalog, Bulletin 8-60, on its vibration test systems to 5,000 pounds force and expanded line of Dial-A-Gain and other vibration instruments. "Unified design" permits expansion of test system force ratings as requirements increase. Instruments include the new Dial-A-Gain double integrator Model 610 for displacement measurement in volts per inch D. A. when sensitivity of accelerometer is dialed. **(Circle EQ RSC #47).**

THE MOST ADVANCED TESTING TECHNIQUES ARE BEING BUILT INTO AMERICAN RESEARCH EQUIPMENT RIGHT NOW!

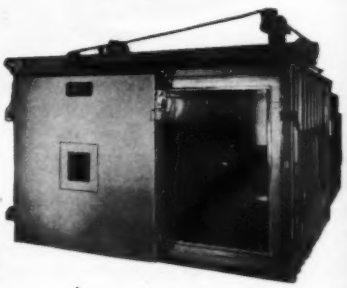


AR

Altitude chambers in any size —Altitude 200,000' or higher; temperature +500°F and higher to —100°F and lower: Humidity 20% to 95%.



◀Sand and dust chamber includes automatic dust density control and streamlined air-flow design.



▲ Altitude, Temperature Humidity walk-in chamber 10' high x 8' wide x 12' deep interior with push-button door controls inside and out.

Designers and manufacturers of Altitude, Temperature, Humidity, Sand & Dust, Rain & Sunshine, Explosion, Special Liquid Chilling and other types of Environmental Test Equipment.

All size chambers available — Write for catalog.

REPRESENTATIVES

Export: Maurice I. Parisier
741-745 Washington St., New York 14, N.Y.

Computing Devices of Canada Ltd.
P.O. Box 508, Ottawa 4, Ontario Canada

Maher Engineering Co.
4335 West Peterson, Chicago, Ill.

AMERICAN RESEARCH CORPORATION
FARMINGTON CONNECTICUT

MEMBER OF THE ENVIRONMENTAL EQUIPMENT INSTITUTE

New 'Guide Reports' Service By N. Y. Testing Laboratories

Quick and authoritative answers to many typical environmental laboratory problems are offered in a monthly service by New York Testing Laboratories, 47 West Street, New York. For less than $20 a year, subscribers receive at least four Guide Reports each month, cutting across all fields of lab work and covering not only conventional approaches but the latest techniques as well. Edited by Roger Harvey, managing director, Guide Reports are drawn from the more than 300,000 test programs conducted by NYTL.

* * *

Technology Instrument Corp., Acton, Mass., has a 4-page catalog on its stable Gold Seal resistors, said to withstand 25 times rated wattage at final inspection. Detailed specs are given on the standard, molded and sealed lines, as well as charts showing temperature coefficients, derating curves and pulse tests. **(Circle EQ RSC #48).**

* * *

Consolidated Electrodynamics Corp., Pasadena, Calif., describes its Type 4-382 pot pressure transducer for low pressure missile applications in a 2-page illustrated bulletin. **(Circle EQ RSC #49).** The Type 4-123A vibration transducer, a thumb-size lightweight device to detect the slightest vibration in jet engines, is described in another bulletin. **(Circle EQ RSC #50).**

* * *

Leeds & Northrup Co., Philadelphia, describes its line of pyrometers to measure temperatures up to 7600° F. in a 6-page illustrated data sheet. The sheet shows the "disappearing-filament" method of comparing filament brightness with object, and lists standard pyrometers and accessories to adapt them to special needs. **(Circle EQ RSC #51).**

* * *

Webber Manufacturing Co., Indianapolis, discusses applications of environmental testing in nine main areas and gives details of 13 types of Webber chambers and freezers in a new 32-page brochure. Striking features are a colored cover with space-black background and pictorial color charts summarizing atmosphere and altitude data up to two million feet. **(Circle EQ RSC #52).**

* * *

Conax Corporation, Buffalo, N. Y., has a new 32-page catalog, No. 1890, on its extensive line of quality thermocouple assemblies and pressure sealing glands. Plentifully illustrated, it discusses mechanics of operation, advantage and applications for the many types shown. **(Circle EQ RSC #53).**

* * *

The Electrical Hotpack Company, Inc., Philadelphia, features seven "Hi-Lo" temperature test cabinets in a new controlled temperature bulletin, which gives illustrations, prices, specifications and operating instructions. **(Circle EQ RSC #54).**

* * *

Auto Control Laboratories, Inc., Inglewood, Calif., concisely describes its facilities and products for environmental, hydraulic and pneumatic applications in a two-color, four-page folder. **(Circle EQ RSC #55).**

* * *

Soc. for Nondestructive Testing Issues Handbook

A comprehensive two-volume handbook covering all nondestructive testing for essential properties and performance capabilities of materials, parts, components and structures has been issued by The Society for Nondestructive Testing, Inc., 1109 Hinman Ave., Evanston, Ill. The handbook sells for $24.

Environmental Miscellany

Name Changes: Alnor Instrument Co., Division of Illinois Testing Laboratories, Inc., Chicago, is the new name for ITL's manufacturing operation. Products include temperature, air and dew point indicators and controllers and transducers ... Idaho Maryland Mines Corporation is now Idaho Maryland Industries, Inc., Glendale, Calif. The company owns Universal Research & Testing Laboratories.

Fiscal Report: Varian Associates, Palo Alto, Calif., manufacturer of electronic and vacuum products, reported an earnings rise of 18 per cent on a sales increase of 23 per cent for the first three quarters of its '60 fiscal year. The 39-week sales were $34,038,525, and net income equaled 67 cents a share. Processing of all Varian orders from customers in Europe, Africa and the Near East began recently at Varian A. G. headquarters in Zug, Switzerland ... Sales of Air Reduction Company, Inc., New York, parent of the Pure Carbonic Company, hit a record first-half high of $104,944,541 this year. They resulted in earnings of $2.03 per share. The six-month, 1959, sales figure was $101,836,859, for $2.01 a share. Stockholders received a 62½-cent dividend last Sept. 6, the 173rd consecutive one paid by the company on its common stock.

Expansions: Linde Co., division of Union Carbide Corp., has formed a cryogenic products department, headed by Glenn A. Murray. The department will concern itself with various low temperature processes as well as missiles and rockets ... MB Electronics, New Haven, a division of Textron Electronics, Inc., has established a laboratory for calibrating and certifying transducers. Results will be equivalent to the National Bureau of Standards under Item 206.001C.

Environmental Consultants

Kruse, Flaherty & Associates have opened offices in Jersey City, N. J., as engineers and designers of environmental and other facilities. One of the principals, E. J. Flaherty, was formerly with Tenney Engineering, Inc.

Both a

PROGRAMMER

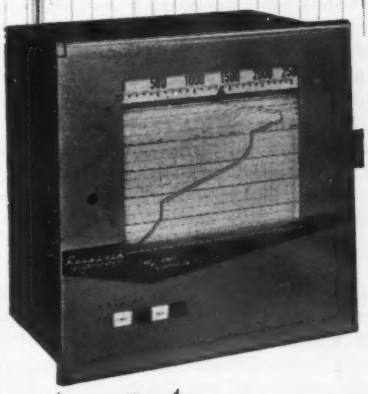
guided by a pencil-drawn curve

NO CAMS

and a

RECORDING CONTROLLER

which superimposes a record of actual process performance and applies corrective control when performance deviates from the plotted program

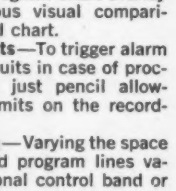


PREKORDER TRADE-MARK

brings new flexibility to the automation of industrial process with closed-loop control.

1. **Pencil Programming** — No cams to cut.
2. **Superimposed Recording** — PreKorder's permanent record of process performance on a program chart overlay permits continuous visual comparison of record and chart.
3. **Programmed Limits**—To trigger alarm or shut-down circuits in case of process malfunction, just pencil allowable operating limits on the recording chart.
4. **Programmed Gain**—Varying the space between pencilled program lines varies the proportional control band or system gain.

Typical PreKorder applications are in programming temperature, pressure, power, load, flow, position, and other process variables. Both round and strip-chart models are available.



RI RESEARCH INCORPORATED

Write Dept. EQ, Box 6164, Minneapolis 24, Minn.

ENVIRONMENTS IN USE...

Simulating Radiation in Orbit

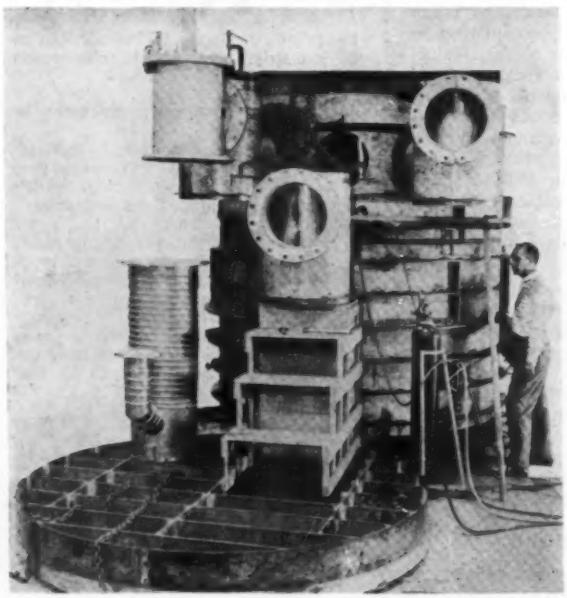
The Problem: Lockheed's Missiles and Space Division needed to know, before launching, that a satellite would function properly despite powerful radiation from the earth as well as from the sun. Its own equipment also generated heat. Some components had to stay within a narrow range of temperatures, yet the radiation on the satellite would vary sharply as it passed through the earth's shadow in its continuous circling path.

THE SOLUTION. Two and a half years ago, Lockeed ordered an orbital simulator from Bemco, Inc. It was to be capable of simulating not only the temperatures and altitudes the satellite would encounter, but to program the complex changes as well. Designed, constructed and installed in only four months, it has been in nearly continuous use ever since.

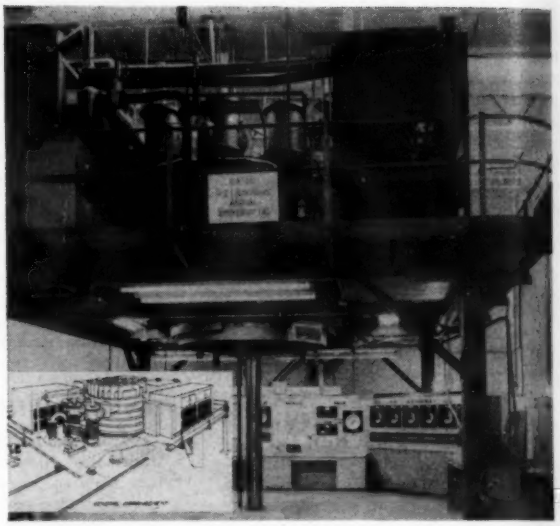
A test chamber 8 ft. in diameter and 9 ft. high was built of stainless steel. To get maximum working space, the chamber and associated equipment were elevated above the laboratory floor where the control console was installed. The bottom of the chamber formed a door, raised and lowered on a hydraulic cylinder and capable of carrying 4,000 lb. Refrigeration, heating and monitoring connections were all contained in the door. Wheels on the bottom of the door allowed it to be rolled on a track to other parts of the laboratory.

The vacuum system was designed to reproduce an altitude of 1 x 10^{-6} mm Hg (about 100 miles), while the range of temperature reached from −320° F to +500° F. It consists of three 16-inch Stokes diffusion pumps, one 6-inch Stokes diffusion-ejection pump, one 1-hp Stokes holding pump, and one 7½-hp Stokes Microvac pump.

The holding pump maintains the diffusion pumps on vacuum when they are warming up or not operating. The Microvac is for roughing. Refrigerated liquid nitrogen traps stop any vapors from the pumps from diffusing back into the high-vacuum, and also prevent contamination from condensable vapors present in the chamber. The chamber is kept at maximum altitude between tests.



The vacuum chamber of Lockheed's orbital simulator during construction at Bemco, Inc.'s plant. Also seen are the stainless steel cold traps and the door.



A view of Lockheed's 100-mile orbital simulator, erected on a balcony as a space saving measure. Diagram shows layout.

An NRC Alphatron registers pressures from sea level to 1 x 10^{-3} mm Hg (about 60 miles) while an ionization gauge reads from 1 micron to 1 x 10^{-7}mm Hg (about 200 miles). Diving the chamber and controlling at various pressures below the maximum pumping ability of the system is provided by a manually adjusted bleed valve and an electrically operated dive valve. Output of both gauges is recorded on a Brown 24-hr circular chart recorder.

A radiant type heating and refrigeration system is used, consisting of 14 black copper segments, each with its own separate controls, instrumentation and programming. Twelve are arranged in a truncated cone, one is overhead and one, the largest, on the bottom door. All segments have cascade refrigeration, the side and top segments using two 7½-hp Brunner compressors with Freon 13 and Freon 22, and the bottom two 15-hp units. The mechanical systems can pull the segments down to −120° F. In addition, the top and bottom segments can be reduced to −320° F with liquid nitrogen circuits.

Heaters Can Supply Up to 500° F.

Electrical heaters can supply 500° F. to the segments but are normally not operated above 320° F. Booster electric heaters in the refrigerant lines provide fast pull-up. To monitor temperatures at various points on the test specimen, 100 thermocouple connections (80 copper-constantan and 20 iron-constantan) are provided. Plug connectors carry external power to the specimen and monitor internal operations of electronic components.

The independent pneumatic controllers of each radiant and refrigeration system may be set at any desired point or programmed separately or in battery. Cams control segment temperatures as a function of time, and master

switches for their drives and the control circuits allow temperature to be preset and all systems started at once. The cam drives are adjustable for the time that the satellite will be in orbit. The shape of the cams takes into account the nature and special effects of radiation in space.

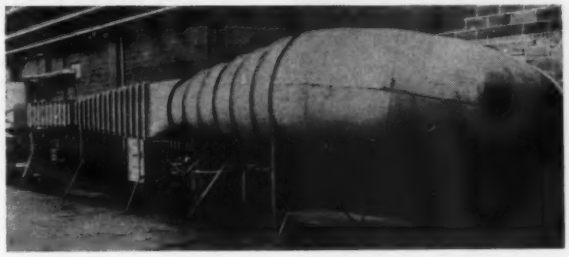
Radiation Changes with Position

As the satellite circles the earth, the various radiations change with its position, and in the test chamber they equal that which the satellite would receive in orbit. Fourteen points on the satellite correspond to the 14 segments, and for each point, a curve is constructed of radiant energy vs. orbit period. From this information, and assuming that the segments act as true "black bodies," the temperature of the appropriate segment is calculated using the Stefan-Boltzman relationship.

Once the desired segment temperature is derived the cams for the segment controllers are designed to maintain this temperature as closely as possible.

Remaining 'Aloft' During Severe Icing and Rain

The Problem: Ascertaining the performance of missiles and aircraft components at varying speeds up to nearly three times that of sound, and under severe icing and rain conditions.



Big bend routes blast of air from room housing twin jet engines which power wind tunnel. Cardox-supplied carbon dioxide pulls down temperatures for icing tests.

THE SOLUTION: Environmental testing in a versatile, multi-purpose wind tunnel powered by two jet engines at Cook Electric Co., Morton Grove, Ill.

Models are subjected to subsonic, transonic and supersonic airflow in the tunnel's three test sections and icing simulated equivalent to atmospheric conditions of temperature, moisture content and droplet size.

General Electric J-47 turbojet engines generate 5,000 pounds of thrust each. Their airstream is passed through a desiccant bed of 75,000 lbs. of activated alumina to avoid condensation effects on the test model.

At subsonic speeds, smoke is injected into the airstream and visual studies of flow conditions are made through large windows in each side of 2 by 2 feet and 2 by ½ feet sections. A rail-mounted optical system permits flow visualization in the 22 by 24-inch transonic section. Three window ports are available for photographing shock waves and other effects from air forced through a fixed wall nozzle between .85 and 1.35 Mach.

For icing tests, ais is colled to 20°F, comparable to that found in natural cloud formations, by being passed over six radiators containing trichloroethylene. These are brought down to temperature through direct injection of bulk carbon dioxide provided by Cardox Division of Chemetron Corporation. The coolant is circulated through a closed system between the radiators and a storage tank. The CO_2 which vaporizes on release, is exhausted from the top of the chamber.

A bank of six nozzles injects a water-air mixture, determined by a flow meter, into the airstream before it reaches the test model. Complete study of droplet size, ice formation and airflow characteristics is made during the icing tests.

CINCINNATI SUB-ZERO CHAMBERS are

TRIPLE-SEALED

Ruggedly constructed, accurate, compact . . . the complete line for testing under conditions of hi-lo temperatures, humidity, radiation, and altitude . . . with

Custom Engineered Design

Double-duty fin-coil blower assembly minimizes temperature stratification . . . serves as primary evaporator. Electric heaters furnished for hi-temp operation.

- Gaskets around doors and lids triple seal
- No seams, rounded corners, electric welded
- Stable non-settling, low conductivity insulation
- Interior galvanized or stainless steel; or with lead liners if specified
- Multipane frostproof windows for hi-lo temp, altitude and humidity testing

For literature and estimates write

CINCINNATI SUB-ZERO PRODUCTS

General Offices & Plant
Paddock at Reading Rd. • Cincinnati 29, Ohio
Representatives in major industrial areas
Member: Environmental Equipment Institute

NEW PRODUCTS...

A "Reader Service Card" requiring no postage is bound into this issue for the convenience of those desiring additional information on new products, new literature (Page 30) and other announcements. It is keyed in the text as "EQ RSC."

COMPACT WALK-IN TEST CHAMBER

by **American Research Corporation** measures only 6' x 6' x 7½' yet has automatic temp control, two-pen round chart recording humidity control, automatic float control of water level, water cooled condenser and safety thermostat to protect heaters from accidental burnout. Temps from —100° to +250° F and relative humidities from 20% between 35° and 185° F.

For More Information Circle EQ RSC #1

LIQUID NITROGEN LEVEL CONTROLLER

by **Consolidated Vacuum Corporation, Type BC-003,** electronically and automatically regulates the flow of liquid nitrogen and other coolants. Designed primarily as an accessory for the new CVC multi-coolant-type vacuum baffles, it can also be used in any similar low temp cooling application. Housed in a wrap-around cabinet. Has magnetic amplifier, critical sensing element, solenoid, relief and manual shut-off valves, pressure gauge and insulated tubing and fittings. Sells for $313 complete; magnetic amplifier and sensing element available separately for $170.

For More Information Circle EQ RSC #2

* * *

BENCH-TYPE, 3-ZONE PRECISION TEMP. BATHS

by **Harris Refrigeration Company** provides efficient means of testing small components. Each bath, 4" across and 4" deep, has the same temp. range as the large triple-unit models offered by Harris for productio nruns. Hot bath range is 150° to 50°, medium bath 50° to 20°, and the cold bath, —20° to —85°, all Centigrade.

For More Information Circle EQ RSC #3

* * *

ABSOLUTE SPACE ACCELERATION COMPUTER

by **Unholtz-Dickie Corporation** computes and indicates true rms value of the three-dimensional space acceleration of a test specimen. Three accelerometers mounted in the vertical direction provide weighted acceleration measurement in cases where distributed structure resonances exist. Acceleration may be sinusoidal, random or any mixture of the two. Readings may be made on a large meter face with a logarithmic scale and 10 db range. Accuracy ±3% 15 to 5000 cps, ±4% to 15 cps. Input impedance: at least 200 megohms shunted by less than 100 micro-micro farads (with 25' low-noise cable). Freq response (each channel): 1 to 100 mv rms/g rms. Acceleration measurement: .3 G to 100 G rms in 5 ranges. Cabinet mounted, 12½" x 24" x 16" deep, 65 lbs. Rack mounted, 8¾" x 19" x 14" deep, 35 pounds.

For More Information Circle EQ RSC #4

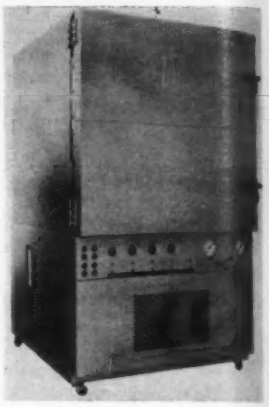
* * *

THERMAL NOISE SOURCE COVERING 15 OCTAVES

Model 300 C by Western Electro-Acoustic Laboratory, Inc., is a new laboratory instrument for synthesizing random vibration shake table operation, high intensity noise chamber and reverberation tests. The extremely stable noise source is derived from thermal agitation within a cold resistor. Features include low microphonic feedback, a filter network allowing selection of equal energy per cycle per octave, and a 15-octave range from subsonic through ultrasonic. Overall size is 19" x 5 1/6" x 7 3/4" deep. It is AC operated and can be mounted in standard racks horizontally or vertically.

For More Information Circle EQ RSC #5

LOW-COST, HIGH-NOISE REVERBERATION CHAMBER



by **PAM Associates, Inc.,** the **Stentor 203** generates 150 db of acoustic power in random frequency down 5 db at 100 cps and down 10 db at 10,000 cps, with instanteous peaks to 155 db. The 27 cf chamber requires 60 cfm of air at 30 psi pressure, available in ordinary shop air supply, has a usable test volume of 40%, and less than 15% sinusoidal input harmonic distortion. Performance is claimed to meet or exceed milspecs for internally mounted jet or missile electronic systems. Priced at $9,950, said by PAM to be half that of comparable units, the chamber is caster mounted and measures 4'3" x 5'4" x 7'6" high.

For More Information Circle EQ RSC #6

* * *

SPACE SAVING LAB OVEN

by **Electric Hotpack Co., Inc.,** fits under the counter yet provides 11 cu. ft. of capacity and a temperature

E. W. A.

(Environmental Want Ads)

Rates: $5 (minimum) for three lines, $2 per line additional. "Situation Wanted" ads free (except for reply box number) to those who can reasonably expect to find employment in the environmental industry, but prescribed form must be followed. First three lines free to those who write own "Situation Wanted" ads. Reply code number $2 extra but no charge for handling replies. Payment in full with copy, except from recognized agencies.

Deadline for Jan., 1961, issue is Dec. 10, 1960. Send order, copy, payment and all inquiries to Environmental Want Ads. Environmental Quarterly, 252-46 Leeds Rd., Little Neck 62, N. Y.

For free "Situation Wanted" ad give only following information in this order: Job title (two permitted), age, (if desired), degrees, recent experience, salary desired, where you prefer to work and name and address. (Last two will be withheld if reply code is used.)

SITUATIONS OPEN

ENVMTL LAB SUPVR, BS/ME, facilities & instrmntn supvr, sal open, EQ#20.

ENVMTL LAB SUPVN, BS/EE, dir envmtl facilities, testg and evaltn. EQ #22.

THERMOSEAL

. . . viewing glass units for environmental chambers. Tolerates —100° to +350° F differential. Prompt deliveries.

. . . tempered glass units and tempered glass now available for rapid delivery.

We also offer engineering service.

THERMOSEAL GLASS CORPORATION

PHONE Glenview 6-3109

P.O. Box 342 • Camden, N. J.

range of 38° to 121° C. A calibrated adjustable thermostat is on a recessed base panel. Of heavy gauge steel, the oven has an exterior 48" x 30" x 36" finished in gray enamel. The double door is free of a center post and three perforated metal shelves are adjustable. The doors are sealed against thermal loss and air infiltration by highly resilient asbestos strips.

For More Information Circle EQ RSC #7

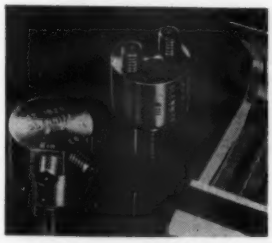
* * *

CENTER OF GRAVITY POSITION FINDER FOR VIBRATION TESTING

The **Cee-Gee Locator** by **Auto Control Laboratories, Inc.**, spots the center of gravity of test specimen and fixture axially along the center of force of the vibration exciter within 10 gram inches. Other features: reduces "cross-talk" substantially, insures that test loads are accurately applied and cuts setup time as much as 90%. **Model CG-50** is 50 lbs.; larger capacities available on special request.

For More Information Circle EQ RSC #8

SELF-CALIBRATING ACCELEROMETER



Model AS 1025 by Gulton Industries, Inc., offers a dual seismic system, one element driving and one sensing, for calibration both before and during flight of missiles or aircraft by means of a square wave oscillator weighing less than five ounces, and for combined environmental tests. The thumb-size accelerometer can also be used as a dual output device on differing scales by using both elements as sensors. Another model, **AS 1030**, has the same characteristics but has top instead of side-mounted connectors. Acceleration range for both models is .2 to 500 Gs, frequency 3 to 500 cps. Sensitivity is 7.5 mv/g min. and capacitance 1000 mmfd min. The resonant frequency is 15 kc min. and a 1 volt drive induces minimum output on the seismic system equivalent to 1 G acceleration. Measuring 1.13" long and .88" in diameter, the AS 1025 weighs 21 grams. The AS 1030 weighs 16 grams. Both are priced at $495.

For More Information Circle EQ RSC #9

* * *

3,000 G PNEUMATIC SHOCK TEST MACHINE

Model SM-005, by Avco Research and Advanced Development Division is said to produce shock up to the equivalent of a four-foot free fall in only seven inches. Only 46 inches high including the base, the machine can develop an impact velocity of 192 ips when the pneumatic cylinder is driven by 80 lbs of air pressure. Shock pulse of 3,000 G in .2 millisecond can be produced, as required by MIL-5-19500B, and specimen loads range up to 30 lbs. A safety feature requires that both hands of the operator be on the control panel at time of impact.

For More Information Circle EQ RSC #10

* * *

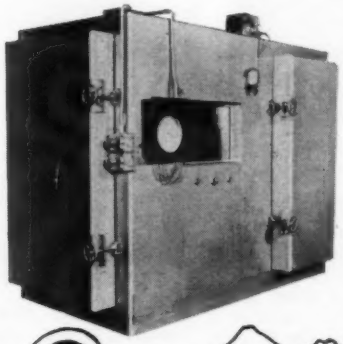
COMPACT OIL-COOLED VIBRATION EXCITER

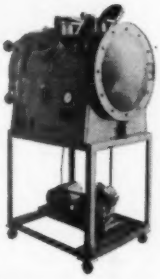
Model EL250, by MB Electronics, produces 2500-pound vector force yet is one-half the size of comparable air cooled units. Designed for both sine wave and random motion testing, the exciter has only a 22 lb. moving element but an acceleration capability in excess of 100 G and a frequency range of 5 to 5000 cps. A new magnetic circuit is said to provide increased flux density and a high degree of efficiency. The exciter is intended for use in environmental test chambers where vibration is combined with

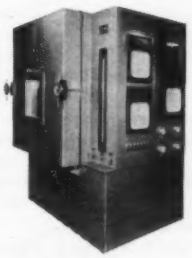
Environmental TEST CHAMBERS

Standard test chambers are expertly designed for accurate, reliable testing. Superior design and quality construction assure years of dependable service with a minimum of maintenance. Whatever the simulated condition desired, there is a Standard Cabinet designed specifically to do the job, guaranteed to give excellent performance.

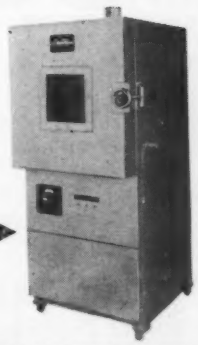
Standard Cabinet Company, a recognized pioneer in the field, has an uninterrupted history of over 18 years under the same ownership and management. It has acquired a wealth of experience and skill in the design and construction of chambers of every description.







ECONO-MODEL



HIGH & LOW TEMPERATURE
ALTITUDE
SAND AND DUST
RAIN AND SUNSHINE
HUMIDITY • FUNGUS
SALT SPRAY
VIBRATION • EXPLOSION
WALK-IN
SPECIAL APPLICATIONS

Write today for free Bulletin No. 60

Standard CABINET COMPANY INC.

MEMBER ENVIRONMENTAL EQUIPMENT INSTITUTE

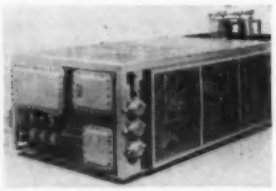
49 WASHINGTON AVENUE, CARLSTADT, N. J.

temperatures from —100° to +300° F, altitudes to 250,000' and humidity to 100%.

For More Information Circle EQ RSC #11

* * *

TRIPLE BATH LOW TEMPERATURE TESTING MACHINE

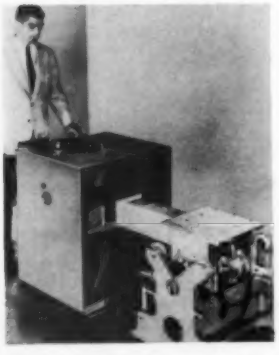


by **Cincinnati Sub Zero Products** permits differing side-by-side degrees of cold for production processing or research testing. All three chambers are welded stainless steel and equipped with individual ¼ hp vertical agitators. Two chambers measure 14" x 20" x 24" deep, and can operate independently at temperatures ranging from —70° to —150° F. Third chamber is 34" long with the same width and depth as the others and can reach 20 degrees lower. Net capacity of the dual cascade water-cooled refrigeration system is about 5000 BTU/hr at —150° F. The machine overall is 141" x 37" x 54" wide and has a 16 gauge stainless steel top usable as a lab table.

For More Information Circle EQ RSC #12

* * *

REACTION-TYPE VIBRATOR FOR COMPONENT TESTING



Model RV-15-25 by L.A.B. Corporation is designed especially for small electronic units and assemblies in accordance with MIL-T-19500 B. Capable of accelerations up to 25 Gs continuous at nominal load, it employs a mechanical reaction vibration generator consisting of a set of adjustable eccentric weights mounted on two rotating shafts. Automatic controls permit unattended operation for 100 hours or more. The machine has a maximum load capacity of of 50 lbs., nominal load of 30 lbs. and table mounting surface of 15" x 15". Freq range adjustable from 10 to 100 cps. Cycling period adjustable from 1.5 to 60 min. per cycle in stepless intervals.

For More Information Circle EQ RSC #13

* * *

ARGON-STABLE CATHODE PUMPING ELEMENT

by **Varian Associates** prevents pressure fluctuations in the pumping of large argon concentrations. Pumping speeds for argon, helium, neon, krypton and xenon can be increased as much as 10 to 1 with the new cathode which is interchangeable with the standard cathode in Varian's **Vacion** high-vacuum pump. It uses the same simple diode construction and the same power supply thereby holding cost down to only slightly more than standard pumps. The new element can be ordered with new pumps or as replacement elements for pumps in the field.

For More Information Circle EQ RSC #14

* * *

PRECISE TEMPERATURE INDICATING CONTROLLER

the **Pyrotroller, by Alnor Instrument Co.** provides both pyrometric temperature indication and electronic on-off control. Available for environmental test chambers in range from —100° to +300° F, it can also be ordered in 11 other ranges from —400° to 3000° F. Measuring only 6 3/8" x 7", it has a die cast aluminum case with black enamel finish for flush panel mounting.

For More Information Circle EQ RSC #15

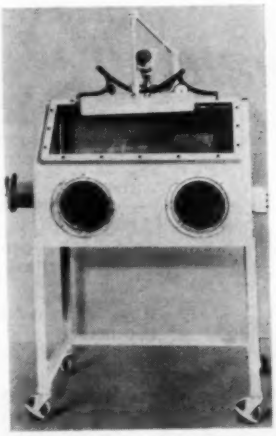
MECHANICAL DIAPHRAGM GAUGE

Model GHD-100, by Consolidated Vacuum Corporation, requires no electrical connections to measure gases from atmosphere to 0.2 mm Hg. Compact and inexpensive, it employs a corrugated copper-beryllium diaphragm whose deflection under pressure is carried by mechanical linkage to a dial pointer. For greater accuracy, the scale has a non-linear calibration spreading the .2-20 mm region over 180 degrees.

For More Information Circle EQ RSC #16

* * *

CONTROLLED ATMOSPHERE VACUUM GLOVE BOX



Model B-20, by Delta Design, Inc., can be used as a vacuum chamber or for welding, brazing, annealing or other handling of toxic or low radioactive materials affected by air contamination under an argon or other gas blanket. Desired atmosphere can be introduced into the evacuated stainless steel chamber with a claimed contamination of less than one part in 10^9 without purging. Work space, 34" x 22" x 22" high. Plate glass window 10" x 28" is externally lit by a fluorescent unit. Entrance ports on both sides permit joining two or more units for tandem operations and assembly work.

For More Information Circle EQ RSC #17

* * *

HOT-COLD-HUMIDITY LIQUID CO_2 CHAMBER

by **Development Engineering Co., Inc., Model C8, CO_2,** features the Develco-Pulse Control System for accuracy of better than ±1° F. in both heating and cooling cycles and controlled rates of operation. The chamber can be brought to —100° F. in a few minutes with liquid CO_2. It has stainless steel interior, external motor and 5" insulation. Illustrated is front-opening door, mounted on a stand with a dry-wet bulb program controller-recorder hooked into the control unit.

For More Information Circle EQ RSC #18

* * *

TALL HOT-COLD TESTING CHAMBER

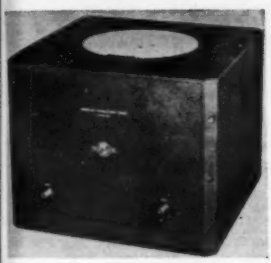
by **Cincinnati Sub Zero Products** is 8'8" high and has two full-length doors each with twin 16" x 24" observation windows as well as four 6" square hand holes and a 20" square access door. With a 120 cf interior, chamber has re-

movable shelves spaced 12" apart for small and large test items. Interior dimensions: 5' x 8' x 3' deep. Refrigeration unit, which can be remotely located, measures 4' x 2'2" x 2'6" deep. Temperatures adjustable from —150° to +300° F. Heat and air circulation provided by two fin coil blower assemblies equipped with 2500 watt heaters. Refrigeration system supplies 800 BTU/hr at —35° F.

For More Information Circle EQ RSC #19

* * *

ANGULAR OSCILLATING TABLE FOR FREQUENCY TESTS



Model 61A, by Micro Gee Products, Inc., subjects gyros, accelerometers and guidance systems to extremely smooth sinusoidal motion. Instantaneous rate information is provided through a pickoff for oscilloscope or recorder presentation. Test loads may exceed 100 lbs. and output torque is said to be above 1 inch-lb. per watt input. Input may be from any good audio, d.c., or shaker amplifier with a 0-100 cps range.

For More Information Circle EQ RSC #20

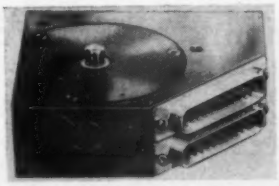
* * *

HIGH SPEED VACUUM DIFFUSION PUMPS

by Consolidated Vacuum Corporation in 2" and 10" casing diameters complete CVC's line of PMC pumps, for which is claimed peak speeds 140% higher than conventional pumps. All have an operating range of 2 x 10^{-7} to 1 x 10^{-2} mm Hg. The 2" model pumps at speed of 105 liters per second over the range of 9 x 10^{-5} to 3 x 10^{-3} mm Hg. The 10" pumps 4100 lps from 5 x 10^{-5} to 1.5 x 10^{-3} mm Hg. As with all PMC pumps, the new models have full load limiting forepressure of .35 mm Hg to no load limiting forepressure of .6 mm Hg.

For More Information Circle EQ RSC #21

MINIATURE COMMUTATOR WITH LONG-LIFE CONTACTS

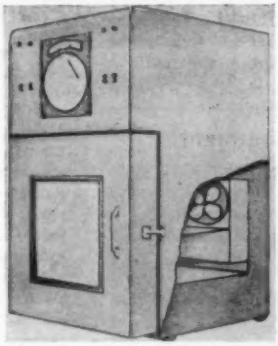


Model 6-15 Rotoflex by Acton Laboratories, Inc., exceeds mil specs (MIL-E-5272C) and successfully operates at 5-3000 cps vibration at 30 Gs; 150 Gs shock, 11 millisec; and 125 Gs acceleration. The commutator, which has special gold foil sealed contacts with the extraordinary long life of over 50 x 10^6 cycles at 500 rpm, weighs only 11 ounces and is but 2 3/16" x 3¼" x 1", a total of 9.14 cu. in. Electrical characteristics include micro adjustable phasing between poles, no sliding contacts and less than 14 ohms equivalent noise resistance.

Circle EQ RSC #22

* * *

BENCH MODEL HI-LO TEST CHAMBER



the SUB-Z, by Cincinnati Sub Zero Products, is a mechanically refrigerated unit adaptable to continuous or intermittent use as a portable unit or in a relay rack. Temperature range —120° to +250° F, with thermal capacity of 400 BTU/hr on the low end. Chamber size 14 cu. in. with shelves adjustable on 1" centers. Full-opening 24" square door has a 12" square frost-free window. Exterior dimensions are 24" x 29" x 40" high; shipping weight 450 lbs. The versatile unit has a Dickson IRC indicating-recording controller with an 8" chart. Altitudes to 200,000 ft. can be incorporated.

For More Information Circle EQ RSC #23

"IT CAN HAPPEN TO YOU"

Testing prior to qualification saves you time, money and effort.

Testing each component and sub-assembly avoids the pitfall of final failure to meet qualification specs.

Too often a design is engineered, fabricated and assembled then submitted to environmental testing. It does not meet the required standards. Then — too late it has to be redesigned and rebuilt.

Acton Laboratories is equipped to test for just about every contingency and prove each step of the design. Final qualification is generally certain. It makes sense — it saves dollars.

Write, wire or call

ACTON LABORATORIES INC.
ENVIRONMENTAL TESTING DIVISION
SUBSIDIARY OF
TECHNOLOGY INSTRUMENT CORP.
533 Main Street, Acton, Massachusetts
COlonial 3-7756 • LIberty 2-2681

ENVIRONMENTAL BUSINESS...

Avco Organizes Industrial Unit

An industrial products subdivision to market products in the areas of high temperature technology and environmental simulation has been organized by the Avco Corporation's Research and Advanced Development division, Wilmington, Mass.

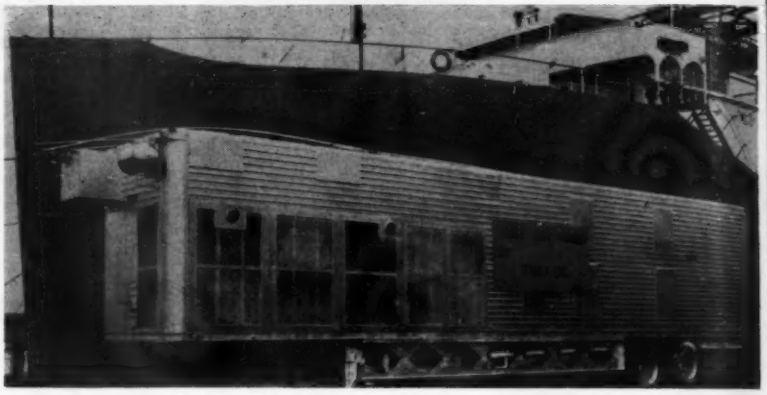
Hawkins

James B. Kerr, president of R&AD, announced that the new subdivision would be headed by Robert A. Hawkins as director of products. Hawkins, who has been with the division since its inception, is also manager of the Quality and Reliability department. He was responsible for setting up reliability programs for the company's work on the Titan and Minuteman re-entry vehicles.

"We are supplying those fields of industrial activity in which we can best make a meaningful contribution," Mr. Hawkins said. "At the present time these are the development of equipment for simulation of extreme environmental conditions such as temperature, shock and high altitudes and those materials and systems associated with high-temperature technology."

He added that the volume of product and service activity at the R&AD division has doubled in two years and that it was felt necessary to recognize this with a formal organization.

Environments Where You Like Them



Tenney Engineering, Inc., Union, N.J., has made delivery of this unique mobile simulator to White Sands Proving Grounds to provide environments for missile parts testing right at the launch pads.

The self-contained, 46-foot semi-trailer, shown at the start of its journey to New Mexico, withstands outside temperatures of —5° to +115° F., rainfall of two inches an hour, 75 m.p.h. sand and dust storms and solar radiation of 400 BTU per square foot while delivering:

Temperatures of —85° to +200°F., relative humidity of 20 to 100 per cent and air flow of 600 to 6,000 cfm.

With its built-in 400-kv diesel electric generator, the simulator costs about $150,000, according to Robert H. Brown, Tenney's vice president-sales. *(For additional information circle EQ RSC "C.")*

Conrad Designs Temperature Conditioning Equipment

A production model temperature coefficient calibration chamber for thermistor and capacitor tests, has been designed by Conrad, Inc., Holland, Mich., manufacturer of environmental equipment.

Hailed as a state-of-the-art breakthrough, the equipment can stabilize within ±.005° C., and additional controls permit stability of ±.001° C.

The temperature range is from +250° to —75° C. Instrumentation for recording the controlled condition can be supplied, as well as automatic temperature conditioning.

Charles F. Conrad, chief engineer, described the chamber as "an important and critical tool needed by science and industry for calibrating measurement and quality control in manufacturing temperature sensitive components." *(For additional information circle EQ RSC "B.")*

Harris Refrig'n In Name Change

Harris Refrigeration Co., Cambridge, Mass., a leading manufacturer of environmental test cabinets and other low temperature equipment, has changed its name to Harris Mfg. Co. At the same time a new firm, Harris Refrigeration Sales & Service, Inc., has been set up to take over service, maintenance and contracting functions of Harris Refrigeration.

Charles C. E. Harris, president, said Harris Mfg. will devote itself exclusively to manufacturing environmental equipment, low temperature refrigeration, biological storage units and "Microtome Cryostats" for the medical profession.

Harris Mfg. remains at the old Harris address, 312 River St., Cambridge. The service company is at 300 Putnam Ave., Cambridge.

Mr. Harris is a former president of the Environmental Equipment Institute.

NAA Orders Big Fatigue Tester from CompuDyne

North American Aviation, Inc., has placed an order with CompuDyne Corp., Hatboro, Pa., for a dynamic fatigue testing machine capable of forces up to 145,000 pounds in tension and compression at frequencies to 100 cycles per minute.

The machine will permit various arbitrary stress and strain programming, and it will be possible to plot high speed specimen stress-strain curves.

Barry Wright Corp. Formed in Merger

Barry Controls Incorporated, major producer of shock and vibration equipment and isolators and isolation systems, and The Wright Line, Inc., supplier of equipment and accessories for data processing, have merged to form the Barry Wright Corporation.

Sales of the two companies totalled $6,742,000 in the first half of 1960, substantially higher than in the comparable 1959 period. For the six months, Barry reported record earnings of 76 cents per share, Wright, 71 cents. Barry's had risen from 61 cents, and Wright's from 60 cents.

Ervin Pietz, who headed Barry, is president and chief executive officer of Barry Wright. R. Perry Collins, president of Wright Line, became chairman of the new company's board. Headquarters of Barry Wright are in Watertown, Mass., home of Barry Controls.

Directors of the two companies had favored the merger as strengthening management, offering greater operating efficiencies and effecting broader diversification. Some 1,600 stockholders of Barry and Wright receive shares of Barry Wright on a one-for-one basis.

Operations of the two companies are continuing at old locations under these divisional names: Wright Line, Worcester, Mass.; Barry Controls Eastern, Watertown; Barry Controls Western, Glendale, Calif.; and Insco, Groton, Mass. Subsidiaries will be: The Wright Line of Canada, Ltd., Don Mills, Ontario; The Barrymount Corporation, Chicago, and Vlier Engineering Corporation, Los Angeles, with a division, Wespo, in Detroit.

Varian Develops Automatic VacIon High Vacuum System

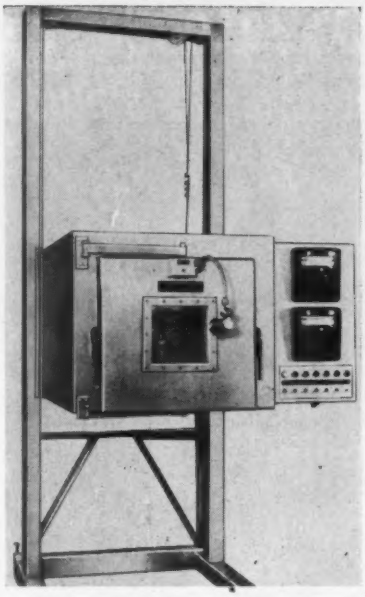
The first fully automatic VacIon high vacuum pumping system has been announced by Varian Associates, Palo Alto, Calif. VacIon is a registered tradename.

A single push-button control starts a completely automatic pumping cycle for research, processing of semiconductor components, evacuating electronic tubes and other applications. Pressure in a bell-jar shaped chamber is reduced to 10^{-8} mm Hg (about 1,000,000 feet of altitude). Return to atmospheric pressure is also automatic.

Developed at Varian less than four years ago, the VacIon pump is completely electronic, using a cold cathode gaseous discharge in a magnetic field to sputter titanium from a cathode plate. Pumping is achieved by chemical combination with the sputtered titanium and by ion burial in the titanium.

Pumping speeds from .3 to 1,000 liters per second are available. The 1,000 liter model, which is used in the automatic system, costs around $25,000. (*For additional information circle EQ RSC "F."*)

Missimers Chamber Has −300° to +1000° F. Range, 'Widest' in a Single Unit



A new test chamber by Missimers Incorporated, Glendale, Calif., produces temperatures of −300° to +1,000° F. Dale J. Missimer Jr., vice president of the firm, said it is the widest range available in a single piece of equipment.

The chamber accommodates a vibration exciter. It is adjustable in height and has casters for mobility.

The announcement did not specify what feature makes the temperature extremes feasible, but noted that expansion and contraction of chambers have tended to restrict ranges.

Missimer said electrical heating brings the new chamber from ambient to maximum in 45 minutes. Carbon dioxide provides refrigeration to −100° in about 20 to 30 minutes, and liquid nitrogen carries it from −90° to −300° in 20 minutes.

Control instruments permit accuracies of ±3° in the high range and ±1° at the opposite end. Air circulation is controlled throughout the working area to insure uniformity. (*For additional information circle EQ RSC "D."*)

Research Firm Organized

Paratron Corp., Carle Place, N. Y., has been organized to do independent reliability research on electronic and electromechanical components. Benjamin K. Sachs, formerly manager of quality control planning at the Ketay department, Norden division of United Aircraft Corp., is president. Under a Navy contract, the firm is investigating causes of precision instrument component failures.

Sachs

Tenney Engineering Acquires Electronics Manufacturer

Tenney Engineering, Inc., Union, N. J., manufacturer of environmental test equipment and refrigeration and air conditioning components, has acquired Communication Measurements Laboratory, Inc., of Plainfield, N. J. CML makes electronic generators and instruments for space systems and for scientific and industrial quality testing.

Saul S. Schiffman, chairman of the board of Tenney, described the move as "an important expansion of our activities in the electronics field." It is expected to add a million dollars a year to Tenney's sales volume. The acquisition mainly involved the exchange of the Tenney stock, which is traded on the American Stock Exchange. CML had been privately owned.

"CML," Mr. Schiffman said, "fits into our long-range program and supplements our research, development and testing experience."

Cryogenerator Adapted For Continuous Cooling

The Norelco Cryogenerator has been adapted for continuous, controlled cooling of environmental chambers, and an attachment is available to liquefy air from the atmosphere as well as cylinder gas.

Controlled cooling is by means of a heat exchanger with integrally mounted blower, which continuously cools and circulates air from 0° to −265° F. Extremely wide range, high efficiency, simple operation and low costs are claimed advantages.

The liquid air attachment produces a gallon of liquid air per hour directly from atmosphere without treatment or compression, a useful feature where small amounts of cryogenic liquids are required.

Based on the Stirling thermodynamic gas refrigeration cycle, the Cryogenerator operates on a direct motor drive at 1,750 rpm. It measures 70 x 40 x 21 inches, and with a 13-cubic-foot environmental chamber fits into a 5 x 11-foot floor space.

Net refrigeration input of 3,500 BTU/hr can be achieved at −260° F., with losses of no more than 500 BTU/hr. For extremely accurate control at high refrigeration demand, a simple solenoid valve replaces the on-off control and cold air is automatically unloaded into an expansion tank.

Cryogenerator refrigeration is said to cost as little as 10c per 1,000 BTU. (*For additional information circle EQ RSC "H."*)

Plan Cryogenic Conference in '61

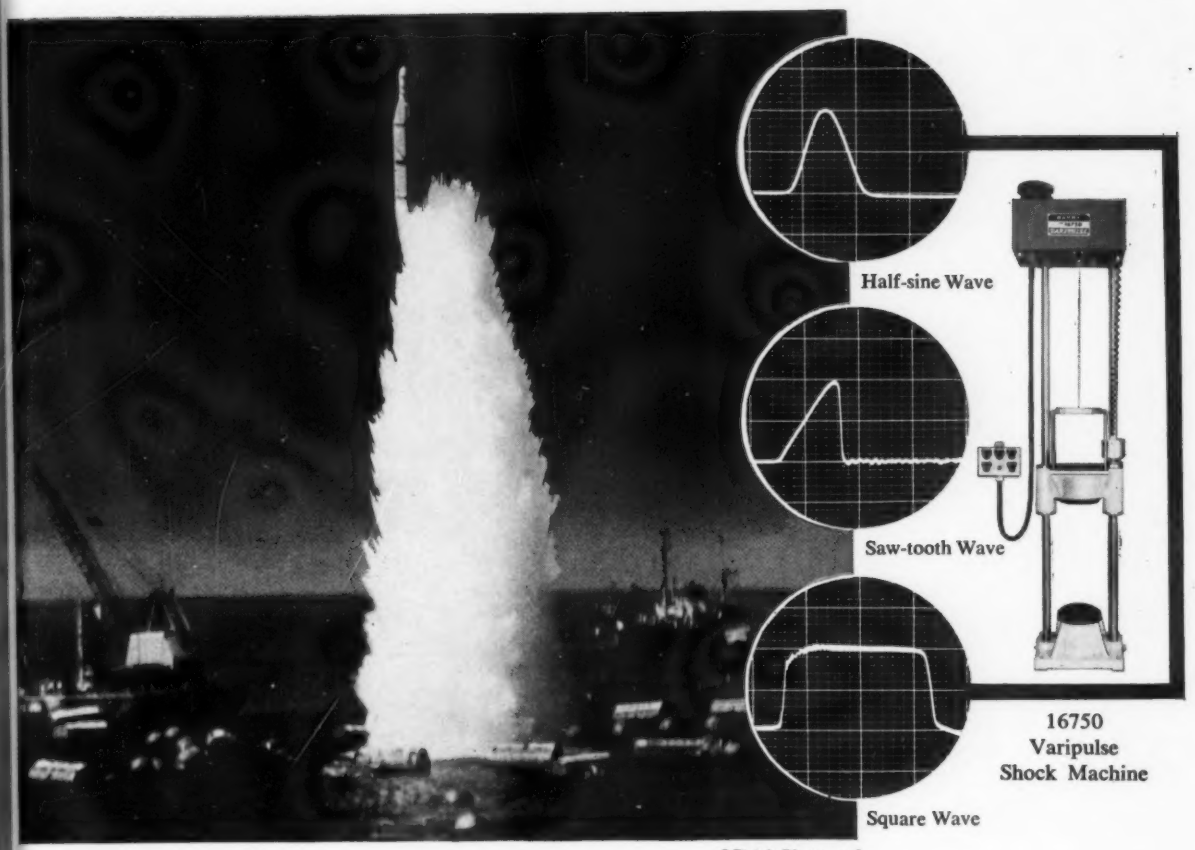
The 1961 Cryogenic Engineering Conference will be held in Ann Arbor, Mich., with the University of Michigan as host. Tentative dates are Aug. 15-17, with abstracts and preliminary papers due May 1, 1961. The first annual award for the best paper will be presented at the 1961 Conference.

Beach-Russ VACUUM PUMPS

get your equipment to higher altitude conditions FASTER

The correct type and size vacuum pump for your specific needs is available from the Beach-Russ line of more than 30 single- and two-stage models. Our experienced engineering department extends an offer of technical help in your chamber development program.

Beach-Russ
COMPANY
420 LEXINGTON AVENUE
NEW YORK 17, N. Y.



Official Photograph
U. S. Navy

SHOCK TESTING

(FIFTH OF A SERIES)

Constant emphasis on miniaturization, combined with the severe environments of the missile age, required a reliable shock-testing machine for small components. The relay, transistor, and miniature-gyro industries in particular voiced the need for such qualification and quality-assurance test equipment. The 16750 Varipulse, with a capacity for specimen sizes up to an 8 inch cube, and weighing as much as 20 pounds, was designed to meet these new requirements. Still retaining the proven simplicity, economy, and reliability of the gravity free-fall principle, the new Varipulse incorporated a number of technical advances in the state of the art of shock-testing. automatic cycling feature, for example, to facilitate production testing. With the new machine, repeated drops can be made from a preset dial-indicated height to establish the resistance of equipment to repeated, identical, half-sine-wave shocks.

Also new is a unique design for the inertia-activated arresting catch, which ensures that the test platform is caught at the precise peak of rebound to eliminate secondary pulses. The catch mechanism is automatically reset during each test cycle, and the drop height is duplicated as often as required by a combination up-limit switch-catch reset device.

Since clean wave forms require controlled machine resonances, design of the elevator and impact-anvil castings ensures complete absence of resonant modes below 2500 cps. Contributing further to elimination of pulse distortion is the damped elevator-support frame and the overall structural rigidity. Particularly valuable to gyro manufacturers is the fact that maximum table rotation about any axis has been held to three minutes of arc.

Able to meet a multitude of current shock-testing specifications, and readily adaptable to the needs of the future, the 16750 is available with a selection of half-sine or saw-tooth pulse producing kits. Special pulses, including square-wave or ramp functions, are developed as easily for the 16750 as they are for the larger Varipulse machines.

So it is that the history of shock testing has progressed from relatively crude efforts to simulate damage, through a comparatively short history of intensive investigation by a number of agencies, to a family of sophisticated instruments of high accuracy, repeatability, and versatility. The history is not yet complete, since new and more challenging requirements are inevitable in the progress into new environments. When those requirements become apparent, look to Barry — leaders in shock simulation.

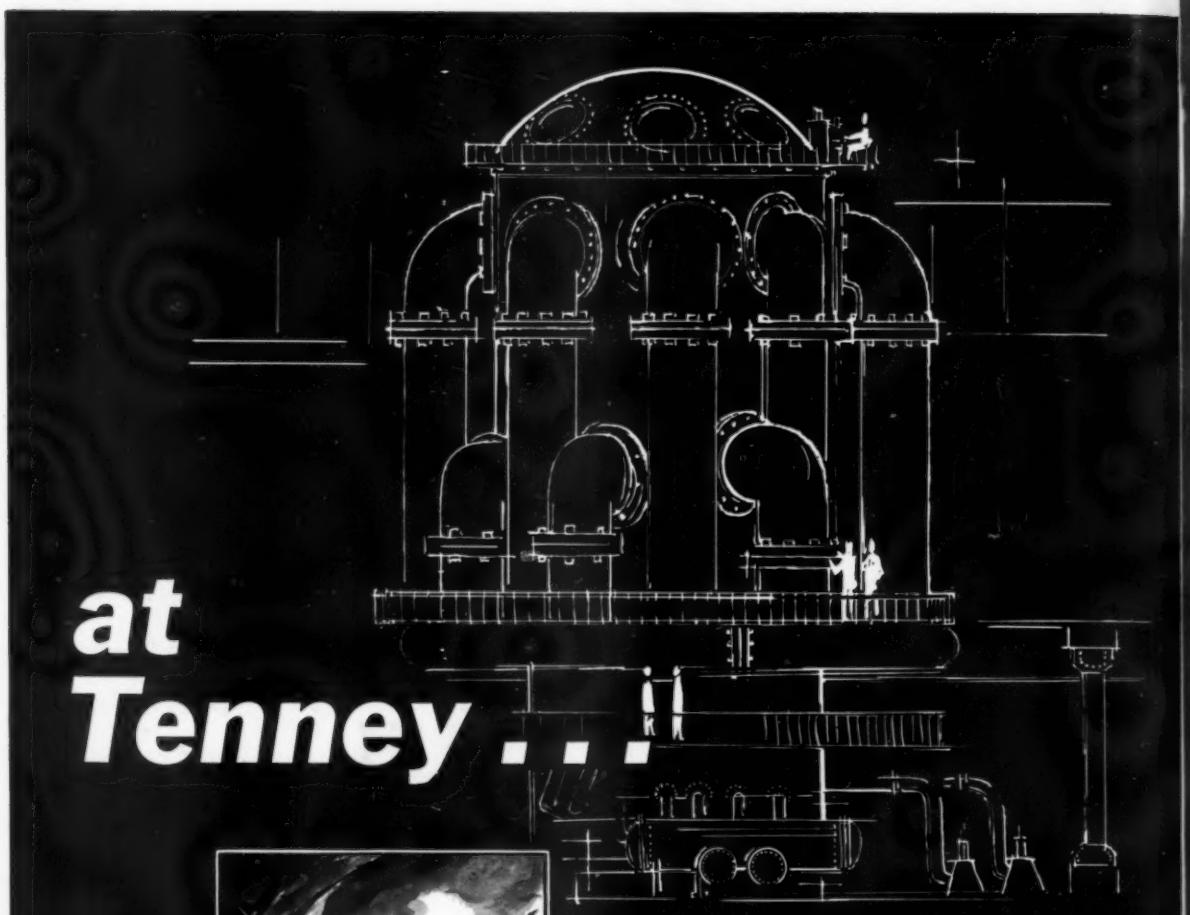
Write for: "Mock-ups for Vibration and Shock Testing" by Charles E. Crede.

Leaders in Shock Simulation

BARRY CONTROLS
INCORPORATED

700 Pleasant Street,
Watertown 72, Massachusetts

1400 Flower Street,
Glendale, California



at Tenney . . .

simulation of tomorrow's orbital environments is today's business

Tenney's research and development in the field of orbital simulation and hyper environments has been bringing high altitudes down to earth throughout the Space Age. No other company can match Tenney's deep engineering facilities and its successful experience with America's most important aerospace projects. Write today for further information about **your** project!

Tenney ENGINEERING, INC.

AEROSPACE DIVISION
1090 SPRINGFIELD ROAD, UNION, NEW JERSEY
PLANTS: UNION, N. J. AND WILMINGTON, N. C.

OLDEST AND LARGEST MANUFACTURER OF ENVIRONMENTAL EQUIPMENT